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METAL INDUSTRY
FABRICATION · ASSEMBLING · PLATING · FINISHING
VOL. 37, NO. 6 JUNE, 1939

Greetings Electroplaters

YOUR committee has worked long and hard to make this 27th annual convention the most memorable of a long series of successful conventions. It has the added prestige of being the Second International Conference on Electrodeposition, in furtherance of the free international exchange of technical information as exemplified by the eminently successful First International Conference, held in 1937 in London, England, under the auspices of the Electrodepositors' Technical Society.

The twenty-nine technical papers on diverse phases of electroplating, finishing and metal treatment, show that these branches of industry are progressive and ready to offer these new developments in competition with other industries. The men who attend the technical sessions will not only reap the benefits of the subject matter contained in the papers presented, but they will gain much from the discussions attendant with each paper.

The congenial, free atmosphere of Asbury Park; the social entertainment; the plant visitations, and the exhibits of plated products, should nicely balance the rigor of technical concentration.

New members attending the convention as well as veterans should feel free to seek advice from the many technical men and experienced platers who will be in attendance.

To the men in Europe who have prepared technical papers for this meeting, we join the membership of the American Electroplaters' Society in expressing our heartfelt thanks for your contributions.

To A. W. Hothersall and other distinguished visitors from abroad, we hope that America will be as courteous to you, as you have been to our members who have visited England in the past. This meeting should serve to promote a better understanding between the workers of Europe and the United States, not only from a technical aspect, but in a better understanding of economic and social problems.

Members of the American Electroplaters' Society—Congratulations on your splendid increase in membership, your widespread interest in promoting education in the science of your industry and the program of your 27th annual convention as a culmination of your efforts of the past year. The future of your Society is bright!

The Dropping Mercury Electrode—A New Instrument for Analysis

A new apparatus has recently become commercially available which enables detection of both basic and acidic ions, qualitatively and quantitatively, with a rapidity and in relative concentration ranges which far transcend ordinary analytical or spectrographic techniques.

Spectrographic analysis has definite limitations of concentration (less than a few per cent), difficulty of determining non-metals, and inability to determine acidic radicals and organic compounds. The time-consuming nature of ordinary analytical procedure is well known. The dropping mercury electrode appears to be free of many of these limitations.

J. Heyrovsky and co-workers first investigated the analytical possibilities of the dropping mercury electrode. Two basic facts were established by him: first, under proper conditions, when an electrode of dropping mercury is employed in a solution, an ion makes its presence known by a current increase at a definite voltage; and second, there is a definite relationship between the amount of the current increase at that voltage and the concentration of the ion causing that current increase.

The technique of analysis using the dropping mercury electrode is as follows: mercury is dropped through a fine capillary into a beaker containing the unknown solution on the bottom of which is a pool of quiet mercury which is the anode of the cell, the dropping mercury being the cathode. Varying potentials between 0 and 3 volts are supplied, with a precision of $\pm$ 0.005 volt, to the drops of mercury as they fall through the solution. A suitable measuring instrument indicates the current.

The procedure is to make measurements of the current which results when a series of increasing potentials are applied to the mercury drops as they fall through the solution being analyzed and to obtain the information desired from a plot of the data thus obtained.

As a simple example, let us assume that the ratio of copper to zinc in brass is to be determined. After dissolving the sample in nitric acid, some of the solution is placed in the beaker cell with a solution of 0.1 N potassium chloride. The concentrations of metal required are exceedingly small ranging from one-millionth to one-thousandth of an equivalent per liter. Thus, for example, from .000031 g/L to .031 g/L of copper are required. A series of potential-current measurements are made within five minutes which are plotted, and for copper and zinc, a curve with two waves will be obtained which is suggestive of the characteristic curve of a vacuum tube or a biological growth curve.

The humps in the curve are of great usefulness. The position on the voltage axis at which the curve rises tells what ion is causing that rise and the height of the rise tells how much of that ion is present. If preliminary quantitative investigations have been made with known standards or in other words, if the cell system has been "calibrated", the relationships between the heights of the humps for copper and zinc will determine the copper and zinc ratio in the solution. It will not be necessary, when the system is understood, to plot a complete curve but merely the significant points required to obtain the heights of the waves must be determined.

The use of a so-called pilot ion serves to eliminate the effects of such variables as temperature and capillary characteristics. This involves the addition of a known amount of an ion which is not present in the sample, making it possible to do quantitative work by comparing the current increase due to the pilot ion with that due to the ion being determined.

Some of the analyses to which the dropping mercury electrode has been applied are: lead in citric acid; copper, lead and cadmium in commercial zinc; copper, nickel and cobalt in steels; rapid determination of sodium and potassium in mixtures of the two; oxygen in dissolved gases; traces of dyes, colloids, fatty acids and alkaloids; and a host of other inorganic and organic compounds.

The technical development of the commercial instrument called an "Elecdropode" has been due to the cooperation of Dr. Ralph H. Mueller of New York University. A complete and informative article on the dropping mercury electrode by I. M. Koltoff and J. J. Lingane appears in the February 1939 issue of Chemical Reviews.

The possibilities of the dropping mercury electrode in organic and inorganic analytical chemistry, in plating solution analysis for control and detection of, at the present time, undetectable organic matter, are intriguing and this new technique should richly reward those who have the fortitude to explore into its seemingly unlimited possibilities.

The Value of the Microscope To the Electroplater—Part I

By Dr. B. Egeberg and N. E. Promisel

International Silver Co.,
Meriden, Conn.

This article shows clearly the various problems in plating that can be studied by the use of the microscope. The photomicrographs are particularly interesting. —Ed.

Uses of the Microscope

The microscope, as applied to the testing and study of electrodeposits, serves a variety of purposes. Often it is the thickness alone with which one is concerned, in which case the microscope is recognized as the most accurate and reliable method. In many cases it is the only useful method, for example, when the thickness of plate on an extremely small area such as a narrow solder seam is to be measured. (Fig. 1). In such a case, the thickness of

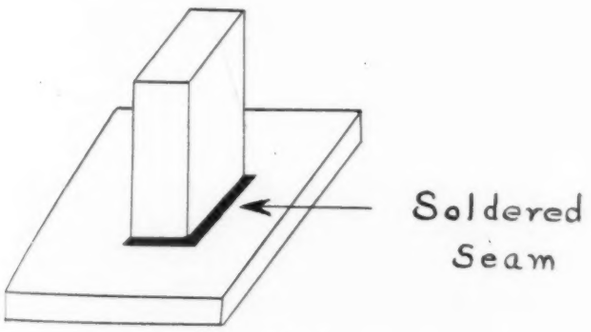


Fig. 1.

plate over the solder and over adjoining metal areas may vary greatly, due to local cell action between the two. In fact, sometimes a solder seam may entirely refuse to be covered no matter how long the deposition is prolonged. The same condition may arise around defects such as oxide inclusions and pin holes in the basis metal. Only the microscope can in such cases give complete, satisfactory information about the local thickness of plate.

In the investigation of an unknown article, preliminary tests have to be carried out to ascertain the nature of the basis metal, the number and nature of the plates, whether or not alloying between the metals has taken place, etc. Obviously, the character of the coating must be first known before proceeding to the actual testing and to the selection of the proper solutions for stripping and for

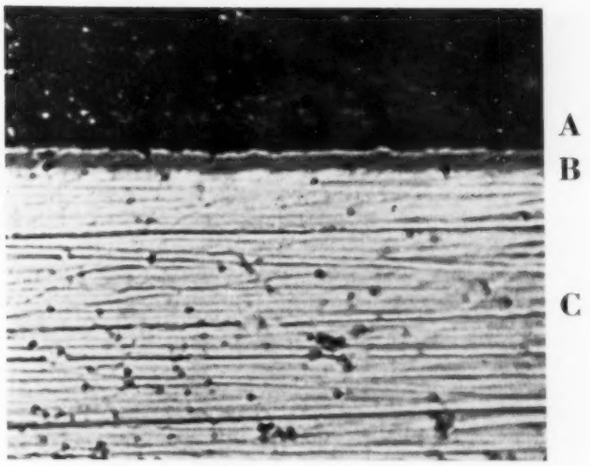


Fig. 2. *Illustrating a silver plate protected from tarnish by top plates of palladium and rhodium. Note difference in whiteness between the three metals. A—rhodium; B—palladium; C—silver.* 2000*X*.

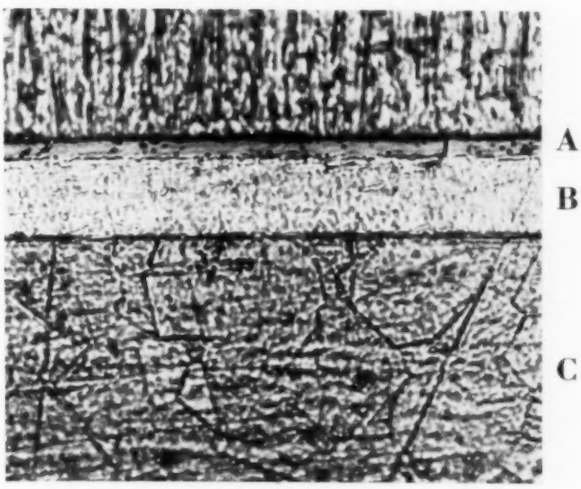


Fig. 3. *Nickel silver basis metal covered by two electrodeposits of different metals. A—palladium; B—silver; C—rolled nickel silver.* 1000*X*.

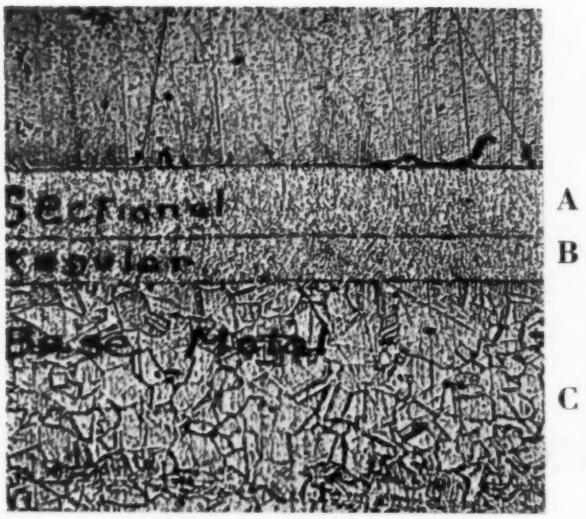


Fig. 4. Basis metal covered by two electrodeposits of the same metal. A—second silver plate; B—first silver plate; C—rolled basis metal. 350X.

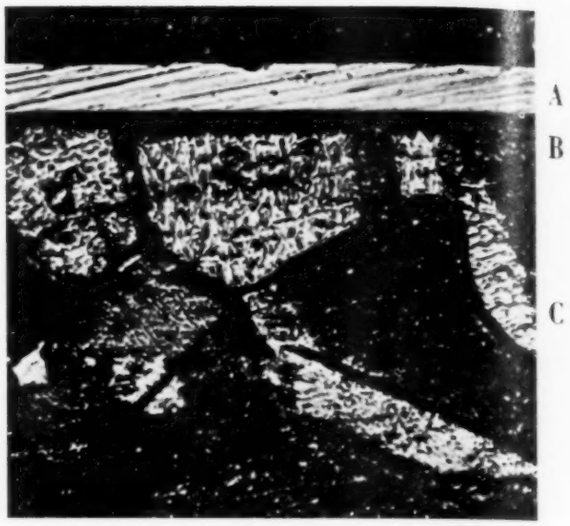


Fig. 6. 14K gold plated over nickel silver and heated. Note alloying. A—14K red gold; B—alloy bond; C—rolled basis metal. 1000X.

chemical spot testing. The microscope is in this respect most valuable. It renders visible more definitely than any other method the various metal layers present. Thus Figs. 2, 3 and 4 illustrate several plates on top of one another and Fig. 5 shows a strike layer followed by the customary heavier plate. The condition of these layers is also indicated, Fig. 6 showing a gold plate "fired" at about 500° F. and Figs. 7 and 8 a silver alloy layer melted and then electroplated.

The relative "whiteness" and characteristic color of any metal is emphasized by the microscope (Fig. 9) and a good judgment as to the composition of the various plated layers can be made. This color observation is made on the unetched specimen and the deductions made may then be verified by etching with various selective solutions to which the plates in question are either immune or to which they show their own peculiar reaction.

The degree of polish, if any, previously given the basis metal or succesive layers of electroplate may often be judged by means of the microscope and also the degree of preliminary etching to anchor the plate, as is required in some instances. Further, it is possible by these means to obtain some indication as to the effectiveness of the cleaning and dipping operations such as in Figs. 7 and 8, showing respectively good and poor contact between two electrodeposits. The latter photo also indicates some frequent causes of rough deposits.

As an illustration of these many important branches of electroplating, with problems which in many cases can hardly be solved satisfactorily except by the microscope, we shall discuss in some detail Fig. 10. It was taken from a worn steel part which had been built up to its original dimensions by electrodeposition of iron. At intervals, a thin copper deposit had been applied to minimize rough-

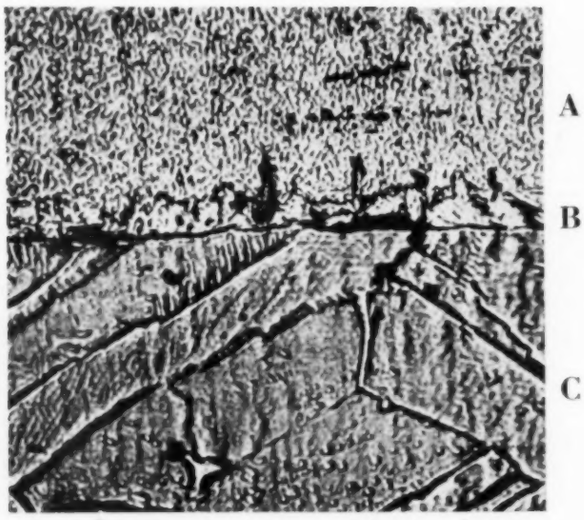


Fig. 5. Photomicrograph shows that strike deposits may sometimes be observed with the microscope. A—silver plate; B—silver strike; C—basis metal. 1000X.

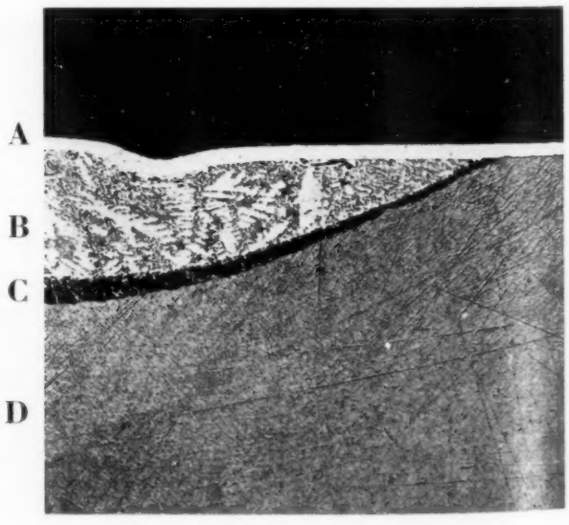


Fig. 7. Silver plated teaspoon showing reinforcement on wearing point by Sterling silver inlay. A—silver plate; B—silver alloy cast structure; C—bond; D—rolled basis metal. 200X.

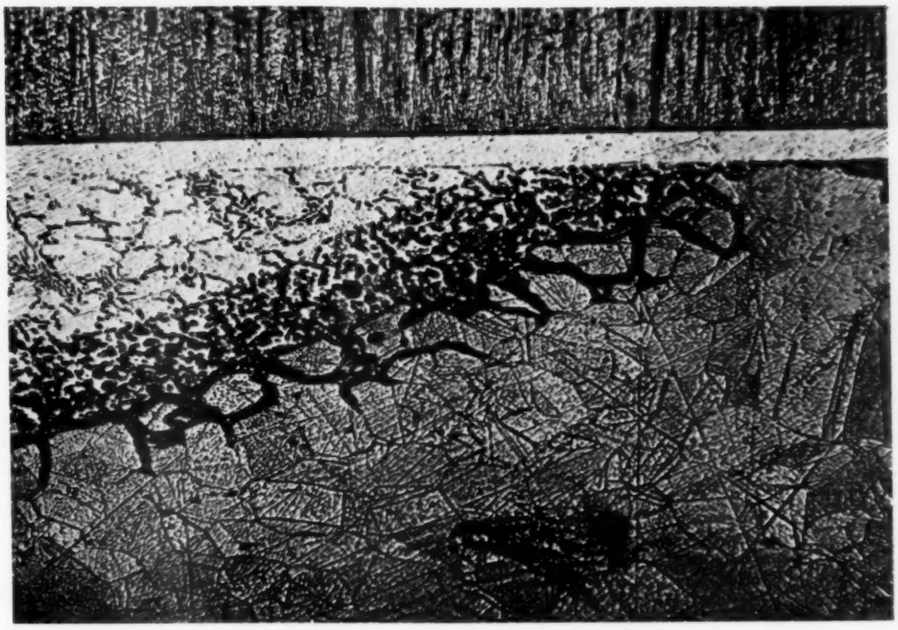


Fig. 8. Same as Fig. 7, showing penetration of the melted Sterling inlay into the nickel-silver basis metal along the crystal grain boundaries of the latter. 350*X*.

ness of the surface. When somewhat over-size, the part was ground smooth and, since it was found to be soft, it was decided to pack-harden it in spite of the presence of the copper layers which were expected to obstruct, to some degree at least, the penetration of carbon. The object was carburized in the pack for 9 hours at 1650° F. and then furnace-cooled. Fig. 10 shows its condition at this stage. The five copper deposits, or their original positions, are plainly visible and also their effect upon the penetration of carbon into the electrolytic iron. Starting at the top of Fig. 10 and moving downward, we find that the surface layer of iron has absorbed carbon to the amount of approximately 0.7%. The first copper layer has been penetrated by carbon, but it has furnished some obstruction because the iron layer below changes abruptly to about 0.50% carbon. The next copper layer has also been penetrated, but it has also been obstructive inasmuch as the carbon content immediately below changes to about 0.20% carbon. The two following layers of copper show no effect and the carbon content remains constant at about 0.20% down to the bottom of the photo. By close observation of Fig. 10, we notice that these two layers of electrolytic copper have been diffused into the electrolytic iron; only their original positions are structurally indicated. The two copper layers next to the surface of the article are, on the contrary, intact; they have not been diffused. From the above, we may draw the following conclusions: the two copper layers next to the surface have remained substantially intact because they were reached comparatively early by carbon absorbed from the pack; evidently copper diffuses much more readily in pure iron than in iron containing considerable amounts of carbon. The two interior copper layers have had time to diffuse into the iron before the carburizing effect reached this depth. As far as can be judged from Fig. 10, copper diffused or alloyed with iron in the amount here considered, does not furnish any obstruction to carburizing, whereas intact copper layers have a great effect in this respect and when thick enough (Fig. 11) are unpenetrable. The required thickness depends naturally upon the time of carburization.

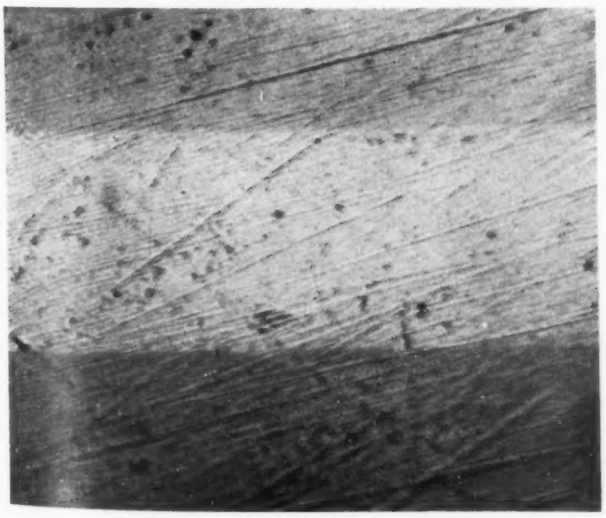


Fig. 9. Illustrating color differences between the various metal layers. Note sharp boundaries. This is the least polishing that can be given a specimen to obtain satisfactory results. 1000*X*.

Preparation of Specimens for the Microscope

We come now to the technique of preparing a section for microscopic observation. Certain precautions are required. If only the surface of the top layer is to be considered, the matter is, of course, simple, but all that one would learn in that case would be the type of finish applied to the surface. A surface blemish of the top plate may, naturally, also be investigated without further preparation of the sample. Usually, however, one wants to make an investigation beginning with the basis metal through subsequent successive underplates to the very top surface of the finished article, in which case, the cutting and polishing of a cross section is required. The area to be polished should not be larger than about ½ sq. in. or, in case of electroplated sheet metal, not more than about ½" long,

about 0.70% *carbon*

intact copper plate, thin

about 0.50% *carbon*

intact copper plate, thin

about 0.20% *carbon*

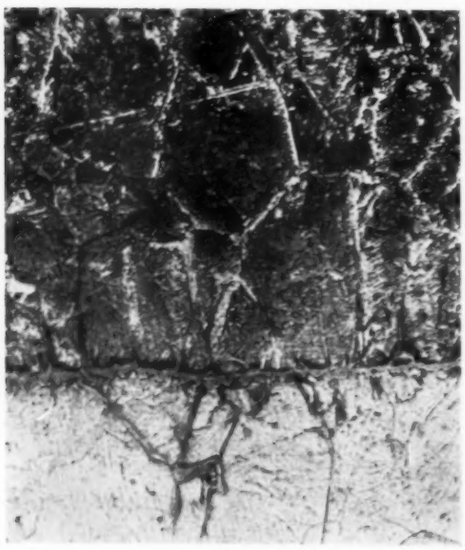
diffused copper plate

about 0.20% *carbon*

diffused copper plate

about 0.20% *carbon*

Fig. 10. *See text for explanation.* 100*X*.



Electrolytic iron with carbon percentage increased to about 1% *by case carburizing.*

Copper plate

Electrolytic iron, carbon free

Fig. 11. *The carbon penetration has been completely stopped by the copper plate.* 200*X*.

since the difficulty of producing a good microsection increases with size. The sample should preferably be cut with a hacksaw so as to avoid the grain distortion caused by a cold chisel or the heat produced by a friction wheel. If one is not interested in the extreme surface edge, but only in regions several thousandths of an inch below the surface, it is sufficient to clamp the specimen as in Fig. 12.

The clamp is made from approximately ⅜" sq. metal stock, with a distance between screws of ¾ to 1 inch. The electrical insulating fiber is inserted between the clamp and sample primarily for convenience during etching. It minimizes the cell action between the sample and the clamp of a dissimilar metal, since clamps cannot be made from every conceivable metal, which is most annoying, especially where etching reagents containing copper are used. Likewise, in the case of anodic etching, one has the current definitely located on the specimen alone and not on the clamp as well.

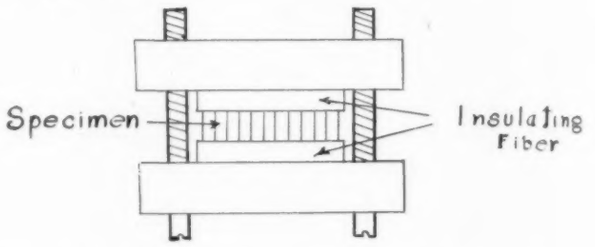


Fig. 12. *Clamp for holding metallographic specimens for preparation for microscopic examination.*

With this method of clamping, a certain rounding of the edge takes place during polishing, so that it cannot be brought into focus simultaneously with the remainder of the specimen. The same is true when fusible alloys, like Wood's metal, are cast around the specimen. If a sharp edge is desired so as to make possible the microscopic investigation of the very surface edge of the cross section, and this is usually the case, other methods must be employed. Most convenient to an electroplater is the deposition of an acid copper layer upon the surface of the original article before cutting it. This gives excellent support to the surface edge of the specimen, which therefore appears sharply defined under the microscope. Most of the microsections here reproduced are backed with electroplated copper.

In case the specimen is curved and made from thin gauge sheet metal, it is best to plate copper sufficiently heavy to avoid clamping, because otherwise, the copper may separate from the sample due to slight bending when tightening the screws of the clamp. A sample ¼" to ⅜" wide may be polished to a flat surface without the assistance of a clamp but this necessitates the plating of copper to a thickness of about ⅛", which requires several days. This delay is many times such an obstacle that a thinner copper is often made to suffice, provided that the sample can be clamped as above described without separation of the copper. Where heat can be aplied, a 400-500° F. anneal relieves the strain, toughening the copper and being helpful in preventing its separation. Such a treatment is, in many cases, not possible due to its effect upon the electrodeposit under investigation (for example with copper plated on zinc metal, or gold plated on copper, as in Fig. 6) and due to the melting of soft soldered seams and articles made from white metals.

After having cut the copper plated sample with a hacksaw so as to expose a cross section of the specimen, it is filed smooth and clamped between fiber, flush with the clamp, or not clamped at all, depending upon the thickness of the electrodeposited copper. This assembly is then ready for polishing.

(*To be continued in July issue*)

Impurities in Plating Solutions

By Vincent Mattacotti

Chemist,
Hanson-Van Winkle-Munning Co.,
Matawan, N. J.

Vincent Mattacotti

This article is a comprehensive review of the source of organic and inorganic impurities in plating solutions as well as methods for the removal of impurities. The author has had practical experience with most of the methods discussed and his experiences should be of interest to all those engaged in the operation and control of plating solutions and to the manufacturers of supplies and equipment for plating.—Ed.

Introduction

The increasing complexity in the makeup and operation of plating baths introduces the need for more rigorous control of the materials entering into electroplating processes. Many formulas of plating baths include chemicals whose concentration is very small. Yet despite the smallness of such concentrations, these chemicals impart very pronounced effects. For example, a very small amount of glue when added to a cadmium solution will produce brilliant deposits. A slight increase in concentration will cause the plate to become brittle and dark. Small amounts of some chemicals are beneficial to a bath while equally small amounts of other chemicals will be detrimental. Since along with brightness other properties such as ductility, adhesion of deposits, freedom from porosity, freedom from inclusions, corrosion resistance, etc., depend on what is in a bath, it follows that knowledge and control of impurities are essential to good and economical operation.

Briefly we shall endeavor to correlate the information available concerning the sources of impurities, their effects, methods of control and removal.

Impurities from Plating Salts

All plating salts entering into the makeup of a bath are capable of acting as sources of undesirable materials. Common impurities found in plating salts consist of iron, lead, copper, zinc, and cadmium. The amounts of such impurities in any given type of salts may vary considerably depending on many factors. The ease with which a chemical may be refined, the tolerance which experience shows to be suitable, and the increased cost involved in eliminating certain minute traces of chemicals are factors to be considered in setting and maintaining standards. While the manufacturers of chemicals have tended toward increasing the purity of their products, we must recognize that limitations will exist as to how pure such materials can be made. A knowledge on the part of the user as to what foreign matter is present in any chemical and what the percentage of this is, will aid greatly in permitting the application of methods for the control of these substances. Means of removing or diminishing the effects produced by foreign substances are available in most cases. Being forewarned as to what is going into a bath enables an operator to prepare such tools as will eliminate prospective trouble.

Impurities from Equipment

Impurities may be introduced from the equipment being used, such as organic material from wooden tanks. This is not very common today, but occasionally crops up. Where air is being used for agitation there is always the possibility of oil contamination from improper or inadequate filtration of the air stream. Steel tanks used in acid and alkaline work and steel anode containers are a source of iron. In many such cases, the iron does not exert very detrimental effects and where there is a possibility of unfavorable results, we find an increasing use of inert liners such as rubber. In silver solutions, it is reported that a high iron content is often the direct cause of stained plate. If there are chlorides present in a solution contained in a steel tank, the rate of solution attack on the steel will be increased bringing higher concentrations of iron into the solution.

Anodes as a Source of Impurities

Anodes can be a source of difficulty under certain conditions. Some impurities such as silicon in copper tend

to make the anode insoluble. Other types of impurities such as silver in copper anodes, gold in silver anodes and copper in nickel anodes, accumulate on the anode surface cutting down the anode solubility. Where a sufficient thickness of such surface "mud" is involved, we often find it necessary to increase the applied voltage in order to maintain the customary amperage in the bath. Again some types of impurities may dissolve into the bath to give undesirable effects. Copper in silver, tin in lead, and nickel in copper anodes go into solution and gradually accumulate to a concentration point permitting them to plate out.

Iron in nickel anodes differs from many impurities in that iron readily dissolves, part of it plating out on the cathode increasing the hardness of the nickel deposit. The remainder is gradually oxidized from the ferrous to the ferric state reacting with the solution to form borates and sulphates of low solubility which precipitate and settle out of the solution. Along with these precipitates, we also get precipitation of ferric hydroxide familiar to all platers. At all times a definite amount of both ferrous and ferric compounds remain dissolved in solution. The amount that plates out on the cathode depends on this

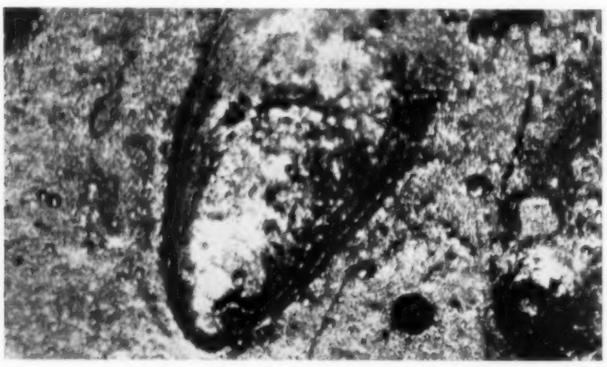


Fig. 1. *Pitting in nickel caused by colloidal organic material.*

concentration. By adding oxidizing agents such as peroxide, all the iron in the bath is converted to ferric iron and precipitates, settling as a sludge.

In zinc anodes, small amounts of copper tend to increase the chemical solubility of the zinc so that the anode continues to go into solution after passage of the current ceases. The addition of small quantities of mercury to zinc retards the tendency for zinc to dissolve chemically so that such an anode is quite passive when the current is off.

Some impurities that may be present in anodes or salts tend to cut down the efficiency at the cathode. In zinc plating the presence of arsenic, manganese or cobalt lowers the metal deposition and increases the evolution of hydrogen.

The presence of lead or chromium in cadmium anodes or salts leads to a cathode polarization effect. Lead also tends to darken cadmium deposits considerably.

In silver anodes small amounts of iron, lead, tellurium or selenium lead to the formation of a black film on the anode which interferes with proper anode corrosion. This type of difficulty is generally encountered only where scrap silver from special sources is used as anode material.

Another source of impurity can be called a temporary source in that the foreign matter is leached out rather rapidly. These impurities, from anode bags and filter cloths, are mainly organic in nature and are encountered when such cloths are not properly washed before use. The organic material leads to embrittlement of the deposits ranging, according to the amount present, from temporary hardness to powdery deposits.

Contamination from Water

In some sections of the country difficulty is encountered that arises from the water being used to make up plating solutions. Some waters are high iron containing, others high in organic matter. Where such water is being used as replenishing water to compensate for drag out, it is quite possible to build up a concentration of these undesirable constituents in the bath making for constant trouble. The writer has had occasion to observe instances where two sources of water were being used, one type such as a stream water for rinses only, while a different line, generally the line containing the drinking type of water, was being used to add to the plating tanks. Such discrimination will pay dividends many times in lowering of rejects and in maintenance of continual operation.

Impurities in Bright Plating Baths

Of considerable interest lately is the increased importance of another source of impurities. With the introduction of bright plating baths, it has been found that the tolerance for certain impurities has decreased below the tolerance of the same baths without brightening agents. Specifically the effects of material such as brass, die castings or iron dropped into the tank are now more noticeable than formerly. In any bright plating bath it is essential that the introduction of impurities from this source be kept at a minimum. Many bright plating nickel solutions operate at a pH below the standard grey nickel solutions. In such increased acid media, any work which falls to the bottom of the tank tends to dissolve faster leading to undesirable effects.

Summary of Impurities

Summarizing briefly the types of impurities and their effects:

1. *Organic impurities.* Typical of this group are such materials as glue, dextrin, resin, and saps from wood or fabrics.

(a) In nickel solutions they tend to give hard deposits increasing in brittleness with increase in their concentration.

(b) In cadmium solutions they tend to increase the luster but again they introduce a decided tendency toward brittleness. Where the use of such materials is desired extreme care must be exercised.

(c) In zinc solutions, their effect is erratic and unpredictable. Some tend to brighten zinc deposits, others tend to darken the deposits.

(d) In silver baths, the tendency is toward a coarsening of the grain structure, at times going as far as to produce spongy deposits.

(e) In copper baths, studies are available on the effect of many organic materials. In general the tendency is toward a refinement of the grain structure with an increase in hardness. Glue

for example, in an acid copper bath in minute quantities leads to hard compact deposits which are inherently brittle.

2. *Inorganic impurities.*

(a) In nickel solutions, the introduction of iron leads to an increase in hardness and a decrease in throwing power. Copper, zinc, lead and cadmium have decided effects on the deposits ranging up to brittle powdery plate.

(b) A pronounced effect is noticed when inorganic oxidizing agents such as peroxide, perborate, or permanganate are present in a nickel bath in excess. Generally the efficiency at the cathode is reduced as well as the throwing power. A temporary increase in hardness also results.

(c) In cadmium and in zinc, the presence of copper and lead produces dark plate. Nickel and cobalt in small concentrations tend to lighten

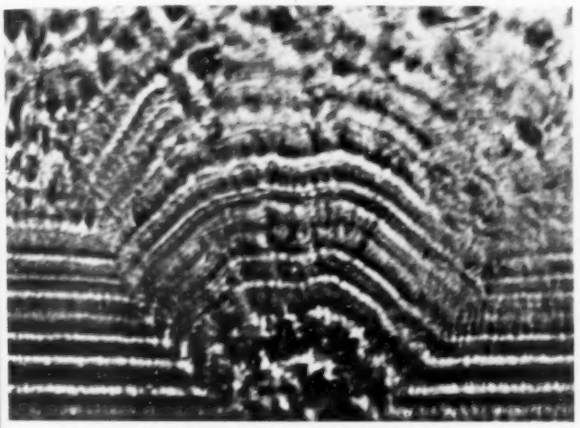


Fig. 2. Banded structure of copper deposit caused by 0.1 g/L of cadmium.

the cathode producing bright effects which are haphazard unless properly controlled. Such deposits do not lend themselves to bright dipping very well.

(d) In cyanide copper solutions, the use of small amounts of lead has been recommended to promote bright plate. The concentration is quite critical and the tendency is toward excessive brittleness. The introduction of silver or cadmium into copper baths leads to roughness and the formation of tree-like deposits.

It is evident from a brief study of the subject of impurities that there is much more to be examined than is at first apparent. Not only are we interested in the deposit from the standpoint of the cost involved in its production, but we are also interested in the quality. Poor plating is a costly matter and where the cause of such plating is discernible and controllable it is to our advantage to put into effect such rules and procedures as will increase the quality of the plate.

Porosity of the plate may be due to suspended impurities such as buffing dirt, insoluble salts, etc. Such porosity seriously interferes with the resistance of the deposit to corrosion. On the other hand, a non-porous deposit might have a very low corrosion resistance owing to the presence of co-deposited material in the plate such as organic matter. It is obvious that any brittleness in the deposits would be injurious and undesirable. Too often we are forced to increase buffing costs because of hard deposits which would not possess such a degree of hardness but for the presence of some substance or factor that could be controlled. The loss of throwing power and efficiency are other difficulties that may have their source in impurities.

Reclassification of Impurities and Their Removal

Although the art of electroplating has not, as yet, advanced to the point where it is possible to effect complete elimination of the sources of impurities and consequently their effects, we do have means with which to recognize or remove such foreign substances when need arises. A list of procedures that are available today indicates that the electroplater has many forms of assistance from which to choose. In many cases, combinations of methods are necessary to effect a solution of the particular problem. In general we may reclassify all the above-mentioned impurities into two divisions; namely, suspended impurities, and dissolved impurities.

Suspended Impurities

Suspended impurities cause roughness and treeing of deposits and are visually apparent to the plater. Where a solution exhibits lack of clarity or turbidity, the use of filtration tends to eliminate difficulties (roughness and treeing) due to this type of impurity. Efforts should be made, however, to trace the source from which the suspended matter comes. In this way, a step toward checking the re-occurrence of such effects is made. The bagging of anodes, complete rinsing of the work before entering

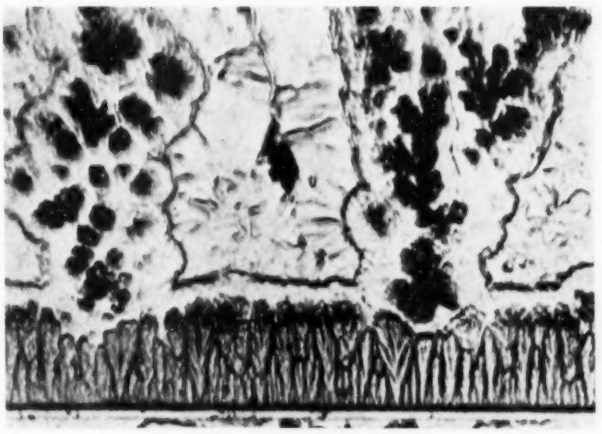


Fig. 3. Treeing and columnar structure of copper deposit caused by 0.1 g/L of silver.

the electroplating bath, cleaning of ceilings from whose surface old paint, dust, and dirt may drop, separation of buffing and plating rooms where possible, all of which are sources of suspended type impurities, should be investigated. The alternative would be the installation of a system of good filtration, preferably continuous type.

Dissolved Impurities

Dissolved impurities can be treated depending on their nature as follows:

1. *Precipitation.* Impurities in nickel baths can be

removed generally by raising the pH to 6.0-6.5 by means of nickel carbonate, sodium bicarbonate or ammonium hydroxide. Many bright nickel solutions use nickel hydroxide in preference to the other chemicals mentioned. Since the use of this compound does not introduce any foreign ion such as the sodium and ammonium ion as do the other two reagents, it would be well, where possible, to use nickel hydroxide. The speed with which the impurities precipitate depends on the temperature, the presence of oxidizing agents such as peroxide where iron is concerned, the degree of agitation used and the concentration of foreign substances present. In general, a temperature of 120°-160° F. is maintained to assist in raising the pH and to carry out subsequent operations. It is recommended that some degree of agitation be provided ranging from ordinary paddle stirring of the solution every fifteen minutes to the use of air or propeller mechanisms. Where air is available and its use will not interfere with any addition agents that may be present in the bath, one can readily perforate a section of garden hose, weight it with pieces of anodes and submerge it in the solution to provide the agitation. The treated bath is allowed to stand for a period of several hours depending on the extent of contamination and is then filtered. Where the chief purpose for running this purification is to eliminate iron, it would be well to take a sample of the filtered solution and check to see if the iron was completely precipitated. To the sample is added ammonium hydroxide in excess i.e., until the sample is a clear deep blue color. The solution is heated and allowed to stand for ten minutes. Any precipitate which has formed will consist of basic nickel compounds and iron hydroxide. The solution is filtered and if the precipitate is decidedly yellow, one may conclude that iron is still present. Where the color of the precipitate is confusing owing to the presence of nickel salts, it would be well to run a confirmatory test. The precipitate is dissolved in a 10% solution of hydrochloric acid. To this acid solution is added ammonium hydroxide in excess and the solution then heated. Iron hydroxide will precipitate as a reddish brown floc very easily recognized.

The foregoing will be recognized as the well-known Liscomb method of purifying nickel solutions. This method is quite extensively reported in the literature and no doubt is familiar to the majority in the field. The addition of ferrous sulphate is frequently advised in this method. The ferrous sulphate is subsequently oxidized in the solution by peroxide and preciptates as a floc tending to drag down other materials thereby hastening clarification of the bath. The writer finds this to be unnecessary most of the time owing to the fact that most nickel baths contain large quantities of iron before purification, which serves the same purpose as any added iron might. Where formerly baths were purified and allowed to settle so that all precipitated material went to the bottom of the tank, it was the practice to syphon off the clear liquid and throw away the mud at the bottom. Today most plants are equipped with filters and with filtering aids such as filter powders, making filtration a faster method of getting the bath clarified than the settling method. The writer has used the Liscomb method extensively during the past two years and has obtained excellent results without the use of ferrous sulphate.

Removal of Inorganic Impurities

1. *Precipitation.* Where inorganic impurities exist in zinc baths, precipitation is resorted to and is brought about by adding zinc dust to the tank. The zinc dust (a pound or so per one hundred gallons of contaminated zinc solution will take care of a considerable amount of impurities) is stirred into the bath thoroughly and allowed to settle out or is filtered out along with the precipitated impurities. Some of the zinc goes into solution replacing the inorganic metallic impurities. This treatment should be carried out after production hours else very bad roughness will be encountered. The treatment is effective in

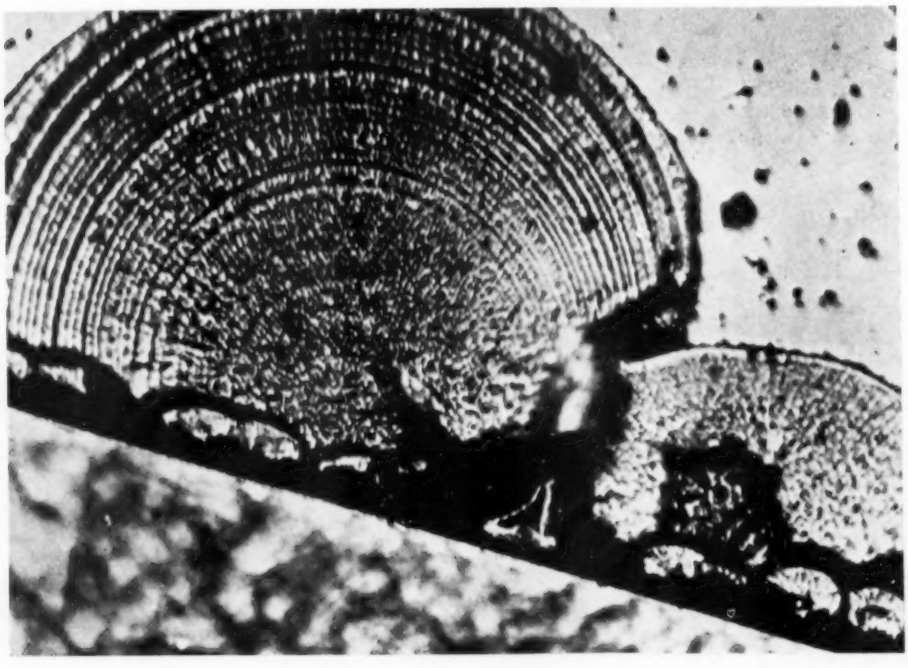


Fig. 4. Nodular and banded structure of cyanide copper deposit caused by the presence of 1 g/L of lead. This deposit is valueless. 1000X.

Fig. 5. Porosity caused by filterable matter in a nickel plating solution.

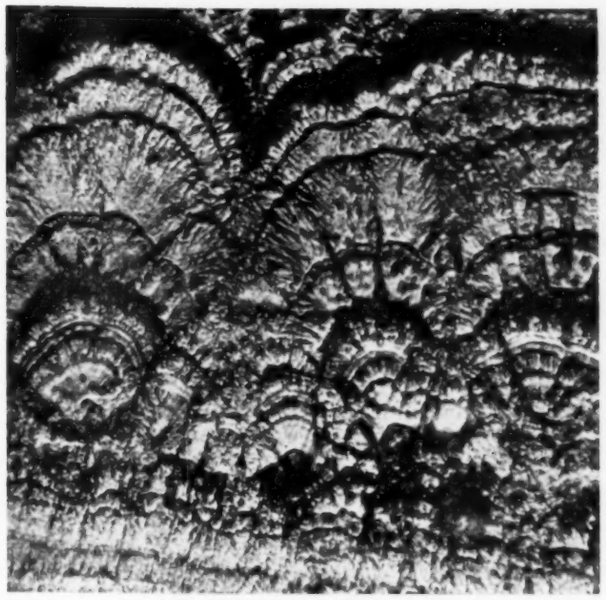


Fig. 6. Nodular structures caused by filterable impurities in a brass plating solution.

the removal of such foreign substances as cadmium and copper. Many times a well operating bright zinc bath will produce even better results after such a treatment showing that a small trace of impurities was present.

In cadmium baths, the use of cadmium sponge in the same manner described above for zinc dust will eliminate many metallic impurities. Where cadmium sponge is not readily available, zinc dust may be used as in a zinc bath. The dissolved zinc will cause a temporary plating of a cadmium-zinc alloy in which the zinc is present in very low percentage and which does not differ in appearance from the straight cadmium deposit. Where metallic brighteners are being used in either the cadmium or zinc baths, these methods of removing certain inorganic impurities may also remove the metallic brightener. In such instances, the supplier should be consulted or provision made for restoring the lost metallic material.

2. *Oxidation.* The use of oxidizing agents is resorted to in order to eliminate many types of organic contaminations and also some inorganic substances such as iron in nickel solutions. Hydrogen peroxide, sodium perborate, and potassium permanganate are effective reagents in the control of iron and organic matter. As an example of such use, occasionally a bath may be severely contaminated with organic material such as starch, glue, dextrin, etc. If the plant is not equipped with filtration apparatus and such materials as activated carbon, the quickest method for the removal of the contamination would be to destroy it with any one of the above-named oxidizing agents. The dose required might run in the neighborhood of one to two gallons of hydrogen peroxide per one hundred gallons of plating solution. The bath should be kept warm as in the Liscomb method to increase the rate of reaction and to expel the unused peroxide as rapidly as possible. Some bright nickel solutions are purified by the permanganate method, this method having been deemed best for the particular solution for reasons connected with these individual baths. In such cases, complete details of procedure are available from the supplier. Where proprietary solutions such as the bright nickel solutions are concerned, it is always advisable to seek the recommendations of the supplier as to which of these methods may be used. Many brighteners, anti-pitting agents, buffering agents, etc. in the various nickel and other plating baths are in themselves organic materials capable of being as readily affected as the impurity one desires to remove.

3. *Electrolysis.* The use of electrolytic methods for removing impurities takes several forms. Low current densities are increasingly used today owing to the fact that many impurities plate out with greater ease at low current densities than at high. Since this method involves but little loss in metal plated out, low current consumption, and very rapid cleanup it has gained greatly in popularity. This method has been discussed by other writers in detail in this journal. The writer has used this method in purifying such solutions as bright nickel, die cast nickel and the regular grey nickel bath. Generally speaking the procedure is to load a tank with as much dummy cathode surface as can be conveniently introduced into the tank. A low current not to exceed five amperes per square foot is applied and electrolysis carried on until the bath is in good plating condition. The amount of time depends on the quantity of impurity present and may vary from several hours to an overnight period.

High current densities are used in very acid baths to destroy organic material and to plate out impurities with a minimum wasting of the main metallic constituents of the bath. Years ago, a procedure was in use involving the purification of nickel solutions to remove organic matter etc., whereby the bath was made very acid and then was electrolyzed at high current using lead anodes. In this manner, chlorine gas was generated from the chlorides in solution at the anode. The chlorine came off into the bath in a very active state and acted as a strong oxidizing agent by which such materials or organic compounds were destroyed.

4. *Carbon Treatments.* The use of activated carbon to remove organic contamination is comparatively recent. Many nickel solutions are periodically treated with activated carbon with a consequent reduction of brittleness and hardness. The carbon is introduced into a filtering system and the contaminated solution is then circulated through this layer of carbon. Organic materal is adsorbed on the carbon surface, which due to the fineness of structure, and highly adsorbent surface has a very high retentive ability. After sufficient circulation has taken place, the carbon is removed from the filter and disposed of. By plating samples in the bath the operator can observe the rate at which the undesirable substance is being removed. There are several things to remember when using such materials. Carbon will adsorb the organics from the bath for a certain period of time, then the tendency is for the carbon to start unloading these organics back into the bath which of course defeats the original purpose. The writer prefers to use small amounts of carbon and renew the charge periodically so as to eliminate the chance of such an occurrence as much as possible. Normally the writer uses four to five pounds of carbon made into a slurry with filter powder. After drawing into the filter the solution is allowed to circulate for an hour or two and this carbon is then flushed out of the filter. A new charge

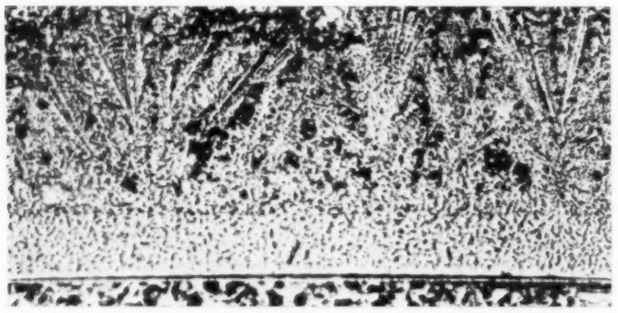


Fig. 7. Rough copper deposit due to 1 *g/L of nickel.* 1000*X*.

is put in and the process continued until the solution shows that it is free from contamination. While this may represent a bit of extra work, it removes the danger of the carbon being used long enough to unload the organic matter back into the bath. Here again we have a method that is not selective and care should be exercised and the advice of the supplier solicited since carbon will also remove many addition agents placed in the bath to produce desired results.

Besides nickel baths, other baths have been treated with carbon to remove undesirable organic material. Acid copper baths in which starch has accidently entered were treated with carbon and the brittleness produced by the starch disappeared quickly. Of interest is the use of carbon to remove excess or undissolved carbon disulphide from silver baths. This treatment has been used with success in cases where spotting on silver has been traced to the presence of such disulphide. In this case it would be preferable to pump the silver solution to another tank, add the carbon, stir thoroughly and filter back to the original tank. The other method involving packing a filter and circulating the solution through the carbon in the filter requires a longer filtration but does achieve the desired results.

Another application of activated carbon is the removal of oil films and droplets introduced from air lines into a plating bath. In an agitated bath, for instance, such droplets of oil lead to spotted work, sometimes to fine pitting and again may be the cause of peeled deposits. By filtering the bath through carbon, this oil is removed whereas without carbon, it might very easily go through the filtering medium.

Bent Cathode Test for Solutions

As previously stated, the most important factor in this subject of impurities is the increasing desire on the part of the operator for information concerning what foreign substances are to be found in the materials he must use to carry out the various electroplating processes. Being forewarned that the addition of a chemical will also introduce other substances and knowing the quantities of these involved, he can predict whether or not difficulties may arise and prepare himself accordingly. Practically all the effects of impurities are readily seen by an examination of the deposit and by the same method, one can determine the effect of any remedy that may be tried. Of great assistance is the use of the bent cathode in determining the condition of the solution and the effects of changes or additions. This simple control method has been widely used for years and deserves, in our opinion, even greater use. Briefly a small strip of polished brass or steel of a standard size such as four inches in length by one inch in width is bent at right angles one inch from the bottom to form an "L" shaped cathode. A sample of the solution in question is placed in a suitable container such as a beaker. An anode and the "L" shaped cathode are arranged in the solution and connected to a source of current. The cathode is plated for a suitable period such as twenty minutes and then removed for examination. The stem of the "L" forms a medium current density area, the base ranges from a high current density zone at the edge closest to the anode to a very low current density zone in the bend of the "L". A solution that has bad plating characteristics will show definite signs in one of these zones. The operator, after brief examination, makes the changes or additions he deems necessary to the beaker. By plating another bent cathode he can observe the effects and determine whether the treatment is the correct one for the main solution. This procedure is quite extensively used in the case of bright plating solutions such as nickel, cadmium or zinc. Its application to dull deposits is indicated where the trouble may be brittleness, pitting, peeling, poor throwing power, etc. Before making changes in large baths, one can conduct the bent cathode test and thus be assured that no surprises spring out to make a badly operating solution behave worse.

Our knowledge of plating solutions is rapidly taking into consideration the specific effects of all constituents that enter into the makeup of a bath. A knowledge of fundamentals is becoming increasingly important as plating specifications become more rigid. Prevention and complete elimination of many difficulties can be achieved by exercising closer control on what goes into a bath.

The writer wishes to acknowledge his appreciation to those men both in the laboratory and in the field whose many contributions in the volumes of the various journals have been used in the preparation of this paper. The photomicrographs are those of Dr. Walter R. Meyer.

Circulatory Systems for Organic Finishing Materials

By Carleton Cleveland

The handling of organic finishing materials such as paint, lacquer and enamel by the use of enclosed circulatory pressure systems is resulting in many economies and reductions in fire hazards. The author has described the essential features of this technique.—Ed.

Introduction

In the finishing operations of large-volume-production methods in modern industrial plants, a veritable revolution has taken place. Prompted by the demands of mass production, inventive genius was put to it to find some means of delivering, during spraying operations, the coating liquids to the discharge point of the guns without delays or interruptions; without the inconvenience in the spray booths of numerous containers; without the messy refillings of these material containers; and without the loss of time necessarily required for frequent cleaning of material containers. The paint circulation system was the logical solution.

The very nature of such an installation in a large plant makes it necessary that each be engineered to meet the respective requirements. However, this is not to be taken as meaning that the paint circulating system is applicable only to large industrial plants calling for the finishing of automobiles, mechanical refrigerators, furniture, radios, electric and gas ranges, farm implements, railroad cars, busses, to mention but a few, since the same advantages, in like proportion, are to be enjoyed by the management of those smaller plants seeking modern and progressive production practices.

Technical Features

Basically, a paint circulating system consists of a tank in which the coating material is mixed; a pump for each line to draw the paint from the tank; and a pipe line to carry the material to the spraying station and back again to the tank. This simplest form of circulating system would contemplate the use of but one color of paint or one type of coating material. Additional tanks and lines are required for each additional color or type of material.

To make the system practical and flexible, however, other items of equipment are essential. When any fluid is forced through a pipe line, the pressure in the pipe varies at different points. This makes it necessary to provide a fluid pressure regulator at all points along the course of the pipe line where it is planned to use paint. This regulator not only equalizes the pressure at each outlet, but it also provides the proper reduction from the main line pressure. The modern fluid pressure regulator has been developed to such a sensitivity that there is practically no perceptible change in the regulated pressure when the spray gun is operated.

The pipe line, naturally, varies in its length to meet existing conditions as do also the number of tanks, regulators, pumps, and other parts of the equipment. The material line is usually $\frac{3}{4}$-in. to $1\frac{1}{2}$-in. pipe with wide bends, the minimum radius being 12 in.

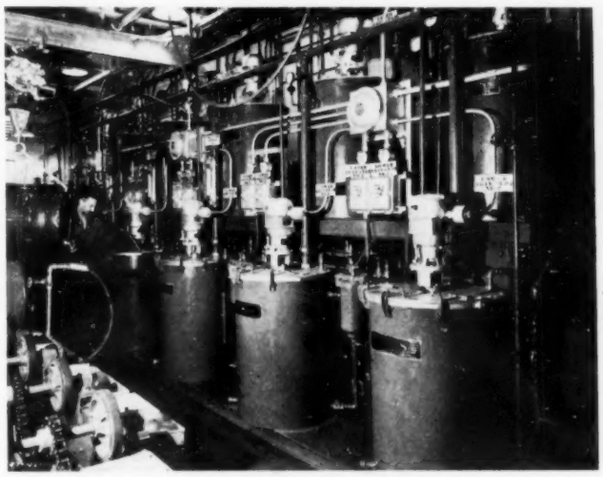


Fig. I. Group of mixing and circulating tanks arranged one above the other and method of handling paint drums, suspended from traveling hoist, when filling containers.

In connection with paint circulating systems, water-wash booths, air filtered booths, and the necessary exhaust system to meet all health requirements are usually installed. The number of booths required varies in different plants, according to requirements, as do also the number of guns in each booth.

When in operation, the finishing material for a paint supply line is put into a mixing tank and thoroughly mixed by a motor-driven agitator. One manufacturer of this type of equipment makes the tanks with dished bottoms and with fixed baffles welded to the inside in addition to the revolving paddles, the better to keep the coating material thoroughly mixed, and the circulating tank agitators are driven by individual geared-head explosion-proof

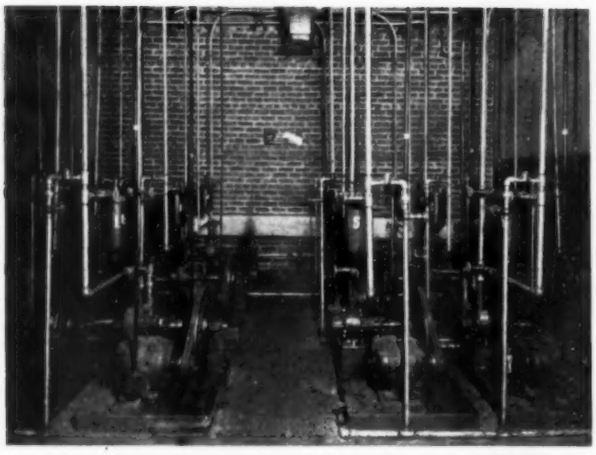


Fig. II. Battery of circulating pumps and filters used in serving circulating paint lines.

electric motors. In many cases two tanks are provided for each line, and pipes are constructed that material can be pumped to the line from either tank and returned to either tank. A new batch can thus easily be mixed in one tank while another batch is being circulated from the second tank, obviating any necessity for interruption of work. The size of the tank depends, of course, on the production requirements of any particular installation. The paint is drawn from the tank through the pump, is strained by means of a filter, and circulated through the line, returning to the circulating tank. Different types of paint require filters of different size and construction. These filters can be cleaned while the system is in operation.

With such a system, each color of paint or each type of material to be applied travels through its own pipe line and through a series of spray booths, at each booth men being busy spraying the product as it passes through the booth on conveyor lines. In a large plant, the material containers are usually of sixty to two hundred gallon capacity. The finishing material circulates constantly under pressure throughout the system during the entire twenty-four hours of the day. The mixing room is usually located at some remote point in the plant, quite a distance from the spray booths. In some instances the mixing room is almost a mile from some of the spray stations.

From the description given it can be seen that the same paint is circulated through all spray booths on any one line in the system and that it is completely enclosed. It follows that the paint is kept clean and that the identical color of paint or other material is delivered to all operators on that line; and with the same force. Pressure is usually regulated by the foreman and the key removed so that no workman can tamper with the mechanism in any way, resulting in uniform work,—even application in the proper thickness by each operator. Sanding and polishing operations are thus lessened.

Further advantages of such systems besides those enumerated above are that the dragging of paint throughout the plant is eliminated, that fire hazards are reduced, and a better degree of plant cleanliness can be maintained, to say nothing of improving working conditions for the men, —all handling of bulk paint and the mixing being confined to a localized area of the plant building, which in many instances is a fire-proof room.

EDITOR'S NOTE:—We appreciate the courtesy of the following manufacturing companies for certain data and the pictures used in this article for illustrations:

Binks Manufacturing Company, Chicago, Illinois,

The DeVilbiss Company, Toledo, Ohio.

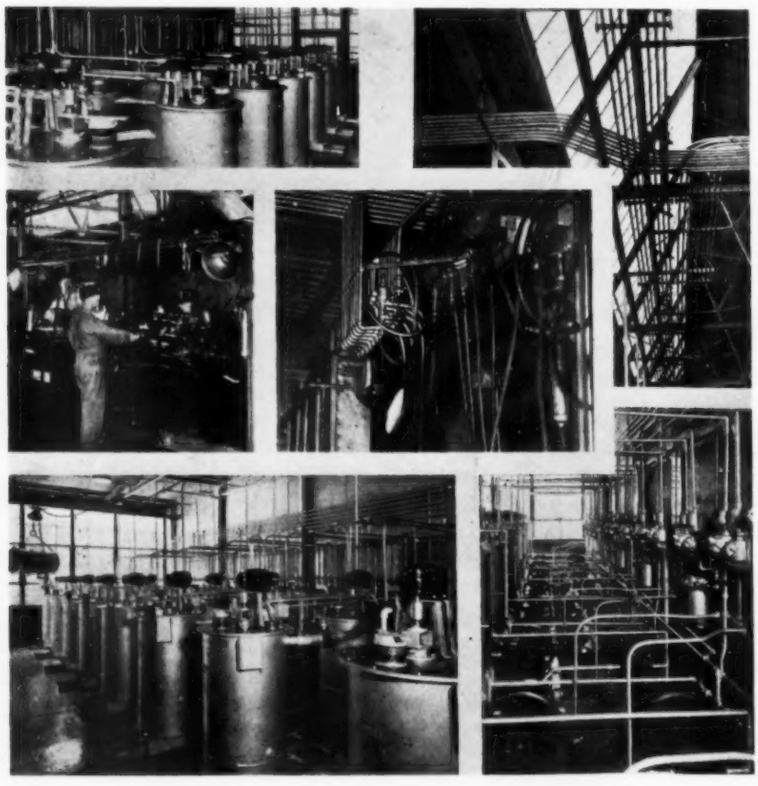


Fig. III. Views at different parts of a paint circulating system.

Constructive Pre-plating Methods

By Frederick Fulforth

The Proctor Electric Co.,
Philadelphia, Pa.

Frederick Fulforth

The author presents in a straight-forward manner a practical discussion of pre-plating methods which have led to savings and better quality of product in the departments under his supervision. The importance of proper steel, handling, polishing and cleaning is stressed.—Ed.

Introduction

Until very recently, practically all thought expended on electrodeposition has been in the improvement of solutions and their control and indeed much work remains to be done along these lines, but the ground work is finished on the older solutions, (insofar as anything may be called finished) and still costs of plating have not been lowered sufficiently to offset increases in thickness now deemed essential to good plating.

It is for this reason that various attempts have been made to realize for the plater, factors entering into his quantity, quality and costs other than the mere operation of applying metal, and by cooperation with the suppliers of these additional items to secure their improvement.

The logical place to start such investigations is before any plating whatsoever is applied, while even before such applications, the determination of the proper base metal and its correct covering is essential.

In explanation of this statement, several clarifying conditions may be cited.

A user of springs for outdoor service had been barrel plating with nickel mainly because the equipment for so doing was in the plant when the work was started, but constant failure and dissatisfaction only caused the plater to endeavor to apply heavier coatings, whereas he should have been able to convince his superiors that a zinc or cadmium plate would not only satisfy the customer but would materially reduce the cost over the heavy nickel deposit then used. Eventually this was done by an outsider and the plater received no credit for going the long and costly way about the job.

Again, there are certain selections of base metals, such as brass for plumbing fixtures, plated tableware, etc., which are almost obvious, but once in a while someone gets started in a wrong manner as observed in a line of marine hardware, which was nickel and chromium plating on cast steel. The initial casting costs were far above those of brass while the type of plating applied, made necessary exceedingly heavy deposits for a protection which could have been secured upon bronze at less than half the overall cost, while the nature of the pieces produced were not justified in their claim of greater strength. The plater should have known all these things and pointed out their impracticability in such a manner that no further thought would have been given them, but we are too prone as a class to think our professional honor involved when asked the possibility of doing an impracticable thing rather than demonstrate a substitute method and prove its advisability.

Improvements in Steel for Plating

It would be impossible, in a limited time, to discuss all possible base metal specifications but as an illustration, steel strip may be selected, since it is probably the most generally used material today while the close analogy of brass thereto in its general manufacturing characteristics allows its inclusion in the general method of treatment.

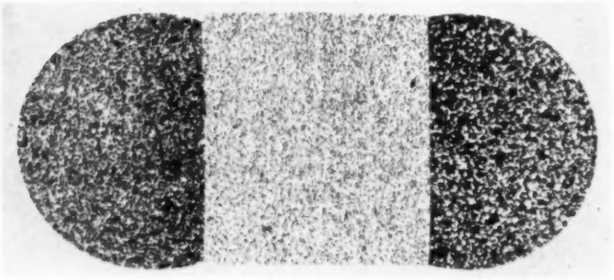
Historically, there were so-called cold rolled steels as short a time as five years ago which could not be plated at all with any degree of uniformity, since they were made by a process known as the one-skin pass whereby a hot rolled ingot in its final stage was allowed to cool and was then given a single cold reduction of a few thousandths of an inch to close its wide open pores and present an acceptable surface finish.

Could this piece have been plated without working or polishing, a presentable job would result, but when put through either of these operations, the thin skin opened to the porous hot rolled structure below, so that the deeper

the polishing went, the more holes developed and when the forming operations became too intricate, the whole skin was liable to crack or fall off, making smooth surface polishing impossible.

By close cooperation with rolling mills, a full cold-rolled strip was developed which had a practically uniform structure. This was by no means the end, however, since other conditions required consideration now that the main fault was eliminated.

It was noticed that in forming operations some edges had a far superior finish to others showing egg shell or orange peel effects and in the search for methods to overcome this condition, grain size was given special attention and by going all the way back to the original billet, methods were developed to control this definitely, and in 1933, the A.S.T.M. issued its standard grain size chart numbered from 1 to 8 with No. 8 having 96 grains or finer per square inch at 100 magnifications.



Comparison of grain size of steel available (middle) against No. 8 A.S.T.M. grain size chart (left & right).

This improvement practically eliminated the necessity for polishing formed edges since the grains were so small that even when distorted, they were invisible to the naked eye or could be easily covered by buffing the plate applied.

From this point, the next logical improvement led to elimination of other surface defects such as slag inclusions, roll marks, handling scratches, etc., and by again returning to the billet and cropping off a goodly portion, the slag was practically eliminated along with some other undesirables while a special development of roll grinding and improvements in the types of mill went far toward cleaning up the rest of the job, more rigid inspection caring for scratches.

Now the steel roller found himself in the position of having done such an excellent job that he could make no profit on his labor and upward price revision was necessary, but the plater went the rolling mill one better to offset this increased cost by almost entirely eliminating polishing costs from his operations and insisting that the mill supply him with steel specified as to:

1. Boxing
2. Papering between sheets
3. Oiling with easily emulsified oils
4. Temper
5. Grain size
6. Special bright finish free from defects

This the rolling mills are doing today to the extent that for normal press shop operations (other than deep drawing), only about 10% requires polishing, while that only necessitates so-called spot polishing to remove defects in the surface about half of which are put there by faulty press work or handling.

The rapid development of bright nickel plating solutions is due in some part to this improved steel whereby some work may be plated to a higher finish without polishing or nickel buffing, and even where some preliminary work is required, compositions of the greaseless type may be economically used in place of set-up polishing wheels.

This is not true where exceptionally high lustre is required, however, as the underlying roll marks, as fine as they are, give a grayish cast to the surface in certain lights which requires nickel buffing to eliminate.

The steel people are working on this problem, however, by experimenting with harder surface rolls and even better grinding equipment so that it is only a matter of time before a still higher surface lustre will be offered, designed especially for bright nickeling—more particularly so as a rumor has come to my attention that one mill is installing equipment and cleaning solutions for the removal of carbon smut at the source.

The other specifications listed have been well covered elsewhere (see METAL INDUSTRY, March 1938 or The Monthly Review, A.E.S., January 1938), and will not, therefore, be further discussed.

Other Factors Influencing Costs of Plating

Following the selection and specification of the base metal and the knowledge of the coating to be applied, further procedure must be investigated to determine minimum cost, allowable with good practice and the meeting of reasonable standards for the type of work considered.

This logically evolves into the fabrication and again without going into detail since these were covered by my article "Lowering Finishing Costs by Press Shop Methods" (METAL INDUSTRY, June 1938), a brief resume would include such statements as my belief that the answer to first quality press work is 90% handling care, proper consideration of receival inspection and storage of raw materials, training of press shop foremen and workers in attitudes sympathetic to the plating department's problems, correct die design and before that, proper part design not only for the work to be done, but for the ease of fabrication and finishing, as well as individually designed work carriers wherein nothing but air comes in contact with significant consumer-appeal surfaces. The design and method of making dies bear a close relation to the final finish procurable as well as adequate process and final inspections, while tied up in the whole problem are lubricants as used in metal stamping, drawing and forming.

Assuming it possible to secure:

1. The sales appeal to warrant any production at all.
2. A happy determination of correct base metal and coating to fulfill all specifications.
3. Perfectly engineered design of plated parts involved in assembly.
4. Proper die construction for their fabrication.
5. Full specifications for all materials not impossible of attainment.
6. Correct methods for fabrication.

7. Adequate storage space and handling equipment.
8. Scheduling possible of timed completion.
9. Sympathetic attitudes of all departments involved with an understanding general supervision, then the salient features necessary to start the plater merrily on his way are at hand and his millenium has arrived.

At this point one may legitimately question where pre-plating methods enter this discussion and the answer lies in the statement that the quality of finish attainable, starts in the earth with the selection of the minerals entering all phases of manufacture, and therefore, it is the plater's business to at least have a general knowledge of all things upon which his livelihood is dependent. Not only must he have such knowledge, but he must be able to cite facts and figures to convince his superiors of their dependence upon his knowing much more than the manner of carrying a rack of work from one tank to another and of his ability and trustworthiness to correctly lead them into profitable expenditures for supplies, equipment and processes in advance of plating procedure.

Polishing of Metals for Plating

Polishing has been the next logical step following fabrication in the past and probably will continue for many years to retain some intermediate place in the scheme of finishing, but its old time art is rapidly falling into innocuous desuetude for several reasons, the foremost of which is the fact that the polisher as an individual would not go along with the modern pattern but insisted upon holding to his medieval art in the same form as practiced in those earlier ages. As a consequence, his place is being largely preempted by automatic machinery and to some extent the almost complete elimination of his efforts by advanced procedures as evidenced in the rolling of steel and other metals to such a high finish, that deposition upon them direct, is more reliable than upon the master craftsman's most strenuous and highly expensive efforts and also by preliminary treatments of metal surfaces by other than polishing means such as bright dips, anodic treatments, patented etching procedures, etc.

Even in the realm of cast iron polishing wherein he has been supremely self-confident of his ability to hold his own against all inroads, the day has already arrived wherein bonded grinding wheels are pushing toward a place in the sun as are also the recently improved tungsten carbide alloys.

As a concrete example, the polishing of household electric iron sole plates some years ago was completed entirely by hand. The introduction of nickel plating with its attendant highly buffed surface called for a better finish than could be afforded by hand polishing, wherefore many companies proceeded to install automatic equipment for this work but practically maintained the hand methods of setting and operating wheels, merely substituting the machine for the manual labor, which naturally increased the total number of wheels operated but decreased the cost by the ease and speed of operation. The bonded wheel makers entered this field to some extent by supplying solid roughing wheels and machinery, but in the final analysis, the abrasive cost was so high that the method was practical but prohibitive in manufactured cost.

While caught on the horns of this dilemma, tungsten carbide entered the field in the form of a milling cutter whereby the single operation replaced all the bonded wheels but retained the ones believed essential as a successor thereto, the Turkish emery headed leather compress wheels.

Now by certain re-arrangements in the cutter teeth and their grinding methods, most of the fine grain emery headed wheels have been eliminated and it is here given as a prophecy that, in a very short time, the whole process will be a combination of one tungsten carbide milling and one or two bonded abrasive operations wherein the total abrasive cost will be only a fraction of the former hand polishing method.

Herein lies evidence of the undesirability of permanently discarding any idea, since the abrasive bonded wheel has its final place at the end of the sequence, whereas, when tried at the beginning it was a comparative failure. In leaving this phase, it is conclusive to state that by the original method outlined, the direct labor cost based on earnings of one dollar per hour, was a total of twenty-six cents per piece while at the present intermediate stage for the identical hourly earnings it is five and one tenth cents per piece with a proportionately greater saving in burden rates.

To briefly summarize, it may be stated that polishing as pre-plating condition has some advantage, although less than in past years, but its conditions must be controlled if the plater is to benefit, since it has been definitely proved by the many interested individuals reported in the literature studying deposition, that scratches have a direct effect on the nature of the plate, allowing the retention of oxides and hydrogen bubbles, which may cause pitting to some extent or misplates of other natures. Again the nature of the lubricating medium in polishing has been important to the plater, but in the evolution of trichlorethylene as a solvent, has become a minor consideration. The ideal for cheapness and solubility in degreasing apparatus is crankcase drainings or other cheap mineral oil which not only dissolves readily, but gives a better cut and more lubrication than animal tallows on the polishing wheel, and for wheel re-heading may be readily removed by the same solvent assuring retentive heads with glue bonds.

Since the bonds are readily removable with steam jets properly controlled and directed against the correctly held wheel, the residual mineral oils are equally easily removable in degreasing machines, no further possibilities of poor head retention on polishing wheels remains when good commercial grades of glue are used under controlled conditions of application and humidity tempered drying. Some success has been claimed by users of water soluble cements but their applications are not universal, as on fine grain emery on sheepskin wheels, but even at this moment an improvement at present unknown to us, may have made their most difficult application practicable which would lower the cost of wheel heading below that possible with glue.

Without spending more time on polishing methods but with the understanding that the subject is by no means exhausted in its relation to the plater, as we have not for instance, even touched on burnishing which is, after all, another polishing method and of a universal character, it would be better to finally get into the plating department per se.

(To be continued in July issue)

The Measurement and Control of pH

By Nathaniel Hall and G. B. Hogaboom Jr.

Ionization, hydrogen ion concentration (pH), and buffer solutions are described. The relative merits of various methods for measuring pH are outlined and the limitations of these methods are given. The paper includes descriptions of electrometric and colorimetric methods for determining pH. The use of pH papers is also described.—Ed.

Ionization

When an acid, base or salt is added to water, the molecules have a tendency to split apart into positively and negatively charged particles called ions, the process being known as dissociation. At the same time, there is a tendency for the ions of opposite charge to combine again to form neutral molecules. Under any given condition of temperature, concentration and pressure there is established an equilibrium between the two processes and the number of molecules which remain dissociated at all times

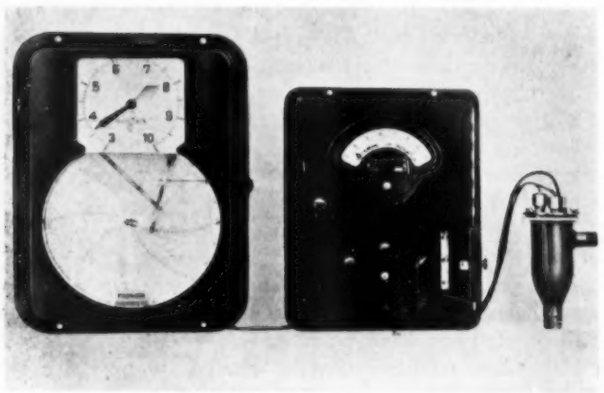


Fig. 1. Potentiometer for pH measurement and control. The glass electrode is completely shielded.
(Courtesy The Bristol Co., Waterbury, Conn.)

is a constant. The dissociation of acids and alkalies results in the formation of hydrogen and hydroxyl ions, respectively, and the degree of acidity or alkalinity is a function of the concentration of these ions. In other words, the solution of an acid in water results in the formation of hydrogen ions which give the solution its acid reaction and undissociated molecules which act as a potential source of hydrogen ions. A strong acid is one in which a large proportion of the hydrogen is ionized, while in the case of a weak acid, very few hydrogen atoms are ionized.

The effective acidity or alkalinity rather than the total acid or alkali content determines a reaction and therefore titration is not a satisfactory method of analysis. To measure the effective acidity, we must determine the hydrogen ion concentration and for the effective alkalinity we must determine the hydroxyl ion concentration. Since in any water solution whether acid, neutral or alkaline, both the hydrogen and hydroxyl ions are always present together and in such relation that their product is equal to 10^{-14} (0.000,000,000,000,01), if we measure one, the other can be easily computed. Both effective acidity and alkalinity may therefore be determined by measuring the hydrogen ion concentration only.

pH—The Expression of Hydrogen Ion Concentration

Hydrogen ion concentration is expressed numerically in terms of normality. A solution having a 1 Normal hydrogen *ion* concentration contains 1gm./liter of hydrogen ions. Since no acid is completely dissociated except in very dilute solutions, the normality of the hydrogen ion concentration must be less than the normality of the acid. The difference is very small for strong acids such as hydrochloric acid but for a weak acid such as 1 Normal boric acid for example, at 25°C only 25 molecules out of each million are ionized.

Since there is an enormous range of hydrogen ion concentrations ranging down to $\frac{1}{100 \text{ trillions}}$ gm./liter in a 1 N. alkaline solution, which even though an exceedingly small quantity of ions, is still measurable, the expression of such quantities in ordinary fractions or decimals is cumbersome and we are indebted to the bacteriologists and biochemists for establishing a simplified method for their expression. The use of logarithms which are notations in powers of 10 was first proposed by Sorensen who recommended the symbol P_{H^+} for the hydrogen ion concentration but the symbol pH subsequently suggested by Clark has been universally adopted because of its simplicity. The symbol pH might be said to stand for the "potential due to hydrogen" which is a measure of the hydrogen ion concentration, and is defined as the logarithm of the reciprocal of the hydrogen ion concentration or the minus logarithm of the hydrogen ion concentration, that is

$$pH = \log \frac{1}{(C_{H^+})} = -\log C_{H^+}$$

Thus a solution containing 0.001 g./l. of hydrogen ions

or 0.001 N. has a pH equivalent to: $\log \frac{1}{0.001} = \log 1{,}000 =$ pH 3.0. The fraction 0.001 is often expressed as 1×10^{-3} from which exponent 3 the pH is often called the hydrogen ion exponent. As another example, let us take a concentration of 0.00000355 g./l. or 3.55×10^{-6}:

$pH = -\log C_{H^+} = -\log (3.55 \times 10^{-6}) = -(\log 3.55 + \log 10^{-6})$ Since $\log 3.55 = 0.550$ and $\log 10^{-6} = -6$; therefore:

$pH = -[0.550 + (-6)] = .(-5.45) = 5.45$

Since the product of the hydrogen ion concentration and the hydroxyl ion concentration is 1×10^{-14} in water solutions and since in pure water they are both equal, the hydrogen ion concentration of pure water is equal to 1×10^{-7} or to use the simpler notation, the pH of pure water is 7. A solution below pH 7 has more hydrogen ions than hydroxyl ions and is acid in reaction while above pH 7 more hydroxyl ions are present and the solution is alkaline.

Buffers

When an alkali is added to a solution of an acid, the hydroxyl ions of the former neutralize the hydrogen ions of the latter forming water molecules and a salt which is characteristic of the acid and base. As the hydrogen ions

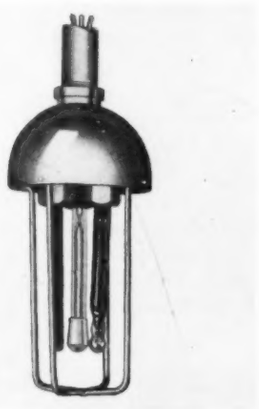


Fig. II. Immersion type electrode.

(Courtesy National Technical Laboratories, Pasadena, Calif.)

are removed, the remaining undissociated acid ionizes to furnish more hydrogen ions until an exactly equivalent amount of alkali has been added. Although the acid has been neutralized, the pH of the solution may not be that of water which is 7, but depending on the kind of salt formed may be higher or lower.

The salt molecules dissociate and some of the ions of one type may combine with water ions of opposite charge so that an excess of the other type of water ions remains. This is called hydrolysis. When sodium acetate for example is dissolved in water some of the acetate combines with hydrogen ions in the water and forms slightly dissociated acetic acid. The excess hydroxyl ions which remain give the solution an alkaline reaction. Therefore when equivalent amounts of a strong base such as caustic soda and a weak acid such as acetic acid are mixed, the resulting solution will be alkaline. If to an acid solution containing sodium acetate is added a small amount of acid, the acetate will tend to combine with the excess hydrogen ions and the pH will not change appreciably. This is called buffer action. A buffer solution is one which resists any change in pH when acid, alkali or water are added.

In buffered solutions, the pH can readily be determined without special precautions against a change but in unbuffered solutions in the range of about 5.5 to 8.5 pH, it is almost impossible to determine the pH accurately since the addition of minute amounts of impurities such as result from contact with a glass beaker will result in a large change in pH. For this reason, we cannot verify the theoretical pH of pure water by pH measurements. Even if such pure water could be prepared, it could not very well be kept at pH 7 because of infinitesmal solubility of the glass or other container in water and the absorption of carbon dioxide from the air. In practice, by boiling to expel the gases and taking various other precautions, a pH of 6.8 may be obtained.

Fig. III. Potentiometer with vacuum tube amplification.
(Courtesy of National Technical Laboratories, Pasadena, Calif.)

Electrodes

The pH of a water solution can be determined electrically by measuring the voltage of a cell consisting of two special electrodes in contact with the solution, using a potentiometer. It can also be measured colorimetrically by comparing the color of solutions of known pH containing an indicator with the unknown to which has been added the

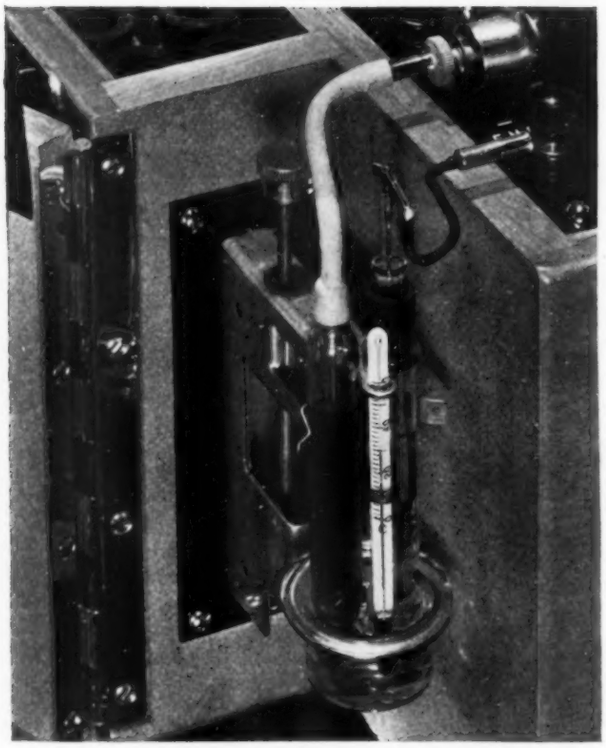


Fig. IV. Universal pH indicator. Close-up of electrode assembly. Notice small size of solution cup.
(Courtesy Leeds & Northrup Co., Philadelphia, Pa.)

same amount of indicator. It is theoretically impossible to determine the hydrogen ion concentration from pH measurements without error so that for all practical purposes the pH values are measured and interpreted as such without any references to the actual hydrogen ion concentration, and when converted to the latter, the figures are used only for estimate or comparison. The electrometric method is the fundamental one by which all others are tested and will be taken up first.

The electrodes used in the determination of pH consist of an indicator or measuring electrode and a reference electrode. A single electrode is not sufficient because its potential cannot be conveniently measured but if two similar electrodes are immersed in solutions of different concentrations their potentials can be compared even though the absolute potential is not known. The hydrogen electrode is the fundamental reference electrode and all other electrodes are compared to it. It consists of a piece of platinum coated with finely divided platinum (platinum black) which absorbs large volumes of hydrogen gas. When saturated with hydrogen and immersed in a solution containing hydrogen ions, it behaves like a hydrogen electrode. The purified hydrogen gas may be supplied to the electrode in a continuous stream or may be confined with the test solution in a closed, agitated vessel. This is the only electrode applicable over the whole range of pH and is highly accurate from 0-14 pH if proper precautions are taken. It is unaffected by the presence of salts or, in other words, it has no salt error. The surface must be freshly platinized and the electrode cannot be used in the presence of foaming solutions, dissolved gases or oxidizing or reducing agents.

Due to the ease with which this electrode is poisoned and the cumbersome equipment required for its use, the hydrogen electrode is usually used only for standardizing or checking other electrode systems. The calomel electrode is usually preferred for routine work. This electrode consists of mercury and mercurous chloride in a solution of potassium chloride in water. The concentration of the potassium chloride may be tenth normal, normal or saturated. The saturated electrode is more generally used than either of the others. It is more easily prepared, has lower electrical resistance and is less affected by small changes in concentration or by diffusion at higher temperatures. Its main objection is the crystal formation on stopcocks which is difficult to remove and may result in breakage. Ordinarily the calomel electrode is used as the reference electrode in combination with one of the other types which is used as the measuring electrode.

The silver-silver chloride electrode which is sometimes used as a standard reference electrode, consists in one type, of a platinum wire surrounded by a mixture of colloidal silver and silver chloride. A suitable electrode is rather difficult to prepare and its most important use today is as an internal reference for one type of glass electrode. Since silver chloride is light sensitive, amber glass should be used for the assembly or the determination made in a dark room.

The simplest of the electrodes is the quinhydrone electrode. It consists of a platinum or gold wire immersed in the test solution to which is added a small amount of quinhydrone. The potential is measured against that of a calomel electrode. Quinhydrone is only very slightly soluble in acid solutions and as long as there is some solid quinhydrone present in the solution, satisfactory results are obtained. The advantages of this electrode are the simplicity of operation, small salt error and relatively inexpensive electrical equipment. These are offset by the disadvantage of contamination of the sample with quinhydrone and limitation to buffered solutions of pH below 8 or 9. It cannot be used with oxidizing or reducing agents and is subject to error in the presence of some salts and metals.

Fig. V. Flow type electrode assembly, glass electrode, temperature correction bulb, calomel electrode.
(Courtesy National Technical Laboratories, Pasadena, Calif.)

(Continued in July issue)

External Heating of Plating Solutions

By Dale Augsburger

Sales Engineer,
The Duriron Company, Inc.,
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A description of external heaters for plating solutions and their advantages are given. Many installations of external heaters have enabled the control of temperature of nickel, copper, and chromium solutions within 2° F.—Ed.

A generation or so ago saw the birth of what is known today as the plating industry. At that time, most of the chemicals, as well as the equipment, were homemade, and each plater had his "secrets" as to how certain limited results could be obtained.

The demands of modern industry, with the cooperation and experimental research of the plating engineer and chemist, have produced methods whereby the finished plated product is durable, as well as beautiful in appearance.

Naturally, a great deal of credit must be given to those who have produced the modern chemicals and methods. However, we should not overlook the fact that present day results could not have been obtained without the aid and cooperation of the equipment manufacturer. His ingenuity and resourcefulness have placed equipment at the disposal of the platers, enabling them to produce the finished product in the most economical manner.

Most present day, and some of the earlier plating solutions, give the best results when some degree of heat is applied. This was usually accomplished by using heating coils in the plating bath. Coils of ordinary materials were fairly satisfactory for most of the cyanide solutions, as well as the acid solutions with a high pH. With the development of the low pH solutions, where higher and closer temperature control is required, it has been found that heating with coils has brought up a number of problems which can be eliminated by the external method of heating.

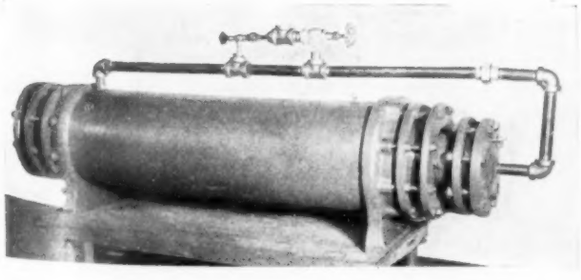


Fig. I. Duriron heat exchanger.

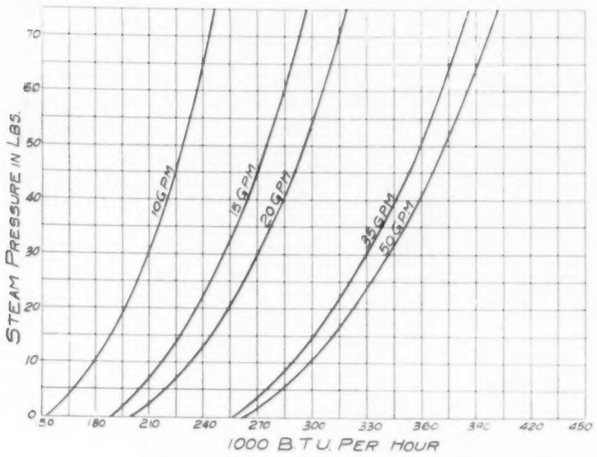


Fig. II. Steam pressure—B.T.U. curve for heat exchanger in Fig. I.

External Heater Characteristics

External heating, the elimination of coils in the work tank, and the circulation of solution through a heat exchanger outside the tank, is especially advantageous for nickel, copper, and chrome solutions, since a high rate of production is usually required, with a minimum of rejections. These conditions are possible with external heating, since the following advantages are obtained:

1—Elimination of loss of solution by siphoning through concealed leaks.

2—Elimination of hot and cold areas in work tank, resulting in a more uniform finished product and fewer rejections. (Temperature variation in many installations is less than 2°.)

3—Production time loss is eliminated, as frequent coil repairs and replacements are not required.

4—Productive capacity of any given size tank is increased, as space-taking coils inside the tank are eliminated.

5—Gentle flow of solution through work tank, caused by circulating through heat exchanger, with the use of higher current density, often allows the cutting down of the plating time.

6—Increased heating efficiency, since a square foot of heating area in the form of heat exchangers is about twice as efficient as the same heating area in the form

of coils. (This is partially accomplished by the turbulent flow of solution, which destroys the insulating film that is formed over the heating surfaces.)

7—For solutions where continuous or intermittent filtering is required, such as bright nickels, the exchanger can be cut-in on the filter discharge line, thereby eliminating duplicate pumping equipment.

External heating of the more corrosive plating solutions would not be so economical if heat exchangers were available only in the ordinary materials. Fortunately, equipment manufacturers for the chemical industry have been aware of the needs of the plating industry.

Duriron, which is a high-silicon iron, and resistant to most commercial corrosives, is chemically inert to all nickel plating solutions, that is, the nickel solution will not attack the Duriron, nor will the Duriron contaminate the solution. Duriron is also highly resistant to chromium sulphate baths, as well as copper sulphate and cyanide solutions.

Duriron heat exchangers are available in two sizes which, by installing in parallel if more than one is needed, will take care of the heating requirements of any size plating machine. Figure No. 1 illustrates along with the heating curve Fig. II, an available heat exchanger.

Figure No. 3 shows a typical heating and filtering installation on a large bright nickel fully-automatic plating machine. A self-priming centrifugal pump, connected to the suction line in the tank, discharges the solution into the filter press. To overcome friction in this particular system, and to allow the use of a lower head pump on the inlet side, a booster pump is used on the filter outlet, which discharges the solution through the heat exchanger and back into the work tank at a number of points, through perforated pipe. This method of discharging assures the even distribution of cleaned and heated solution. By-passes are provided, in order that the heating will not be interrupted during the periods

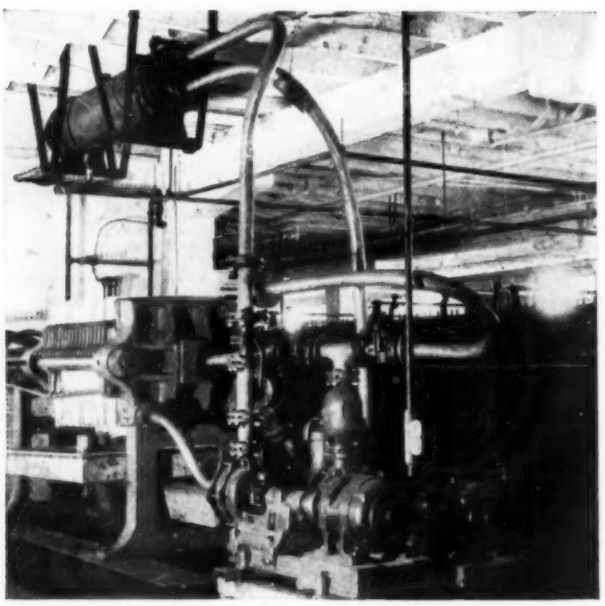


Fig. III. Typical installation, consisting of Duriron heat exchanger, Duriron pump, valves, pipe and fittings, and filter press.

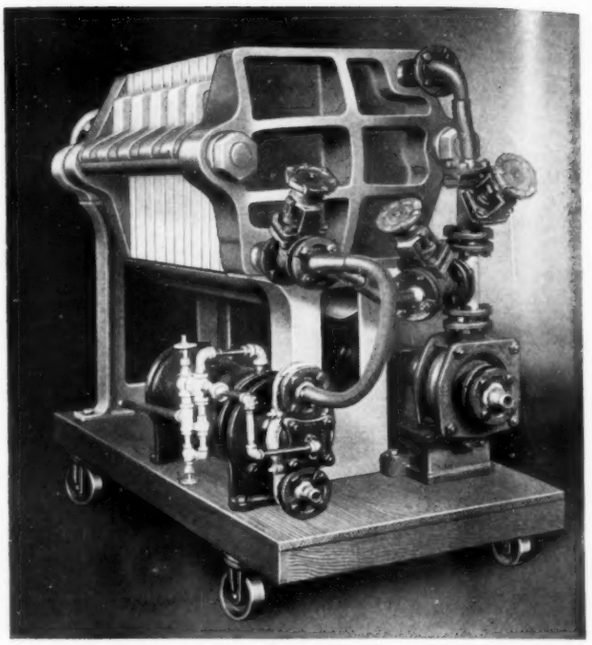


Fig. IV. Semi-portable unit, consisting of Duriron heat exchanger, Duriron pump, valves, pipes and fittings.

when the press is down for cleaning, or when no filtering is desired.

Figure No. 4 shows a combination heating and filtering unit for tanks of 2,000 gallons, or less, capacity. This type unit, though smaller, is essentially the same in principle as the installation shown in Figure No. 3, since heating and filtering are both done in one operation, and by-passes are provided so that the filter can be cut out when no filtering is desired. Units of this type are particularly adaptable to the requirements of the small or medium-size plating plant, as they are compact, can be installed at a minimum of expense, and being semi-portable, can be used for filtering only, of solution in other tanks over the week-ends, when the regular work tank is not in use.

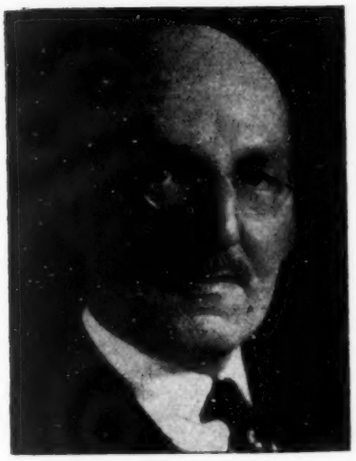
Temperature Control for Chromium Plating Solutions

The heating and cooling of chrome baths, by the use of coils, has in most cases been an exceedingly annoying and expensive proposition. It is now possible to maintain proper operating temperatures by the external method of heating and cooling. The cycle of flow is similar to nickel and copper heating, that is, the solution is pumped out of one end of the tank and discharged through either the heater or cooler, as the temperature indicates, and back into the opposite end of the tank. A system of this type is fully automatic by the use of temperature control equipment, which controls the quantity and path of the solution, as well as the steam and cold water valves. Here, too, temperature variations can be held to a maximum of one or two degrees, and the agitation set up by the movement of solution through the exchangers is of a decided benefit in obtaining a more uniform and better finished product, with fewer rejections.

Automatic Plating

By George B. Hogaboom

Engineer,
Hanson-Van Winkle-Munning Co.,
Matawan, N. J.



George B. Hogaboom

The author, who has had many years of experience in designing, and working with automatic equipment, describes the versatility of automatic equipment. The sequences of operations used in cleaning, pickling and plating are discussed in detail.—Ed.

Introduction

The opinion is often expressed that a large production of a similar line of work is necessary for the installation of full automatic electroplating equipment. When the flexibility of the operation of a full automatic in conjunction with semi-automatic plating machines and still tanks is fully considered it is readily apparent that all the possibilities of automatic installations have not been, in general, fully appreciated. The adaptability of composite installations to several classes of work and kinds of electrodeposits is almost unlimited. The quality and quantity of production brings an economy that with the present trend of costs cannot well be overlooked.

Specifications for electroplated coatings are here. Many large manufacturing organizations have issued specifications that are gradually being enforced. At present some concessions are being made but these will be eventually withdrawn and unless methods are adopted and equipment installed to produce the required standards of electrodeposited coatings, rejections will impress upon producers the truism of the old adage "the survival of the fittest," or, in other words, the survival of those plants that are well equipped. The cycle through which work passes and the adaptation of still tank or semi-automatic machines are given in the illustrations.

Types of Units

When different metals are to be deposited, the cleaning can be done on a full automatic machine, and at a provided place, the racks holding the work can be transferred to other plating equipment in which plating can be done. After plating, the racks are again placed on the full-automatic machine, carried through rinse waters, a dryer and returned to the starting point. In one illustration (Figure I), two nickel solutions, one for light, the other for heavy deposits, an alkaline copper, and a cadmium solution are operated in semi-automatic machines. This combination makes it possible to do several classes of work with a minimum amount of travel by the platers.

In a unit where steel pieces are to be copper plated and brass articles nickel plated, the steel work goes through the full automatic continuously while the brass articles are removed at a convenient place, transferred to a semi-automatic nickel plating machine and then returned for rinsing and drying.

There are many places where a full-automatic cleaning, rinsing and drying unit brings about a distinct economy in production. The flexibility of these units is such that not only several classes of work can be processed, but also permits many different metals to be deposited.

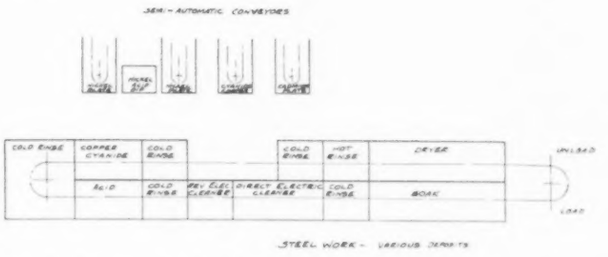


Fig. I. Automatic cleaning and drying unit with semi-automatic plating conveyors.

According to the place in a plating plant where a unit is to be installed, the loading place can be at the side or the end of the plating machine.

Some work can be better processed in a "straight-away" machine in which several lanes of work can pass between rows of anodes. This type of machine can be

used where a continuous straight line flow of work is required.

The cycle of operations described, is not a set one, but is illustrative of what can be done. There are several modifications that can be made to fit in with the nature of the work to be processed. Steel articles that have on them a heavy grease from the polishing operation, or slushing or drawing oils, or compounds are more effectively cleaned if given a primary "soak" in a soap solution, or in an alkaline compound that contains soap compounds or soap forming materials that will emulsify the mineral oils or grease if present. Solvent emulsions can

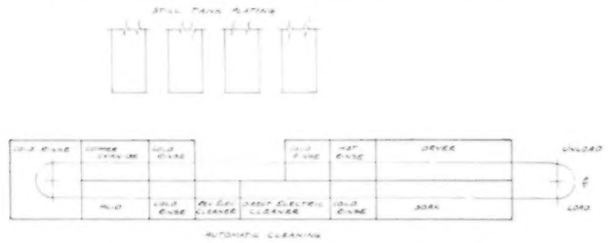


Fig. II. Semi-automatic cleaning and drying unit with still plating tanks.

be used. At present the value of "wetting agents" in alkaline compounds is under close observation.

There is no universal wetting agent that can be used in both the acid and the alkaline solutions used in electroplating. Some wetting agents work excellently in alkali cleaners but care should be used not only in their selection, but in the cleaning operations so that the wetting agent or compounds formed are not carried over by "drag-out" through the rinse waters and into the acid dips or the plating solutions. While the surface tension on the work may be reduced by a wetting agent there can be compounds formed in the alkaline solution, the following dips, or other solutions that will act as repellents to water. If work is removed too rapidly, foam may be created that increases the difficulty of the thorough removal of the cleaning solution in the rinse waters. The result is staining or water-breaks which are so often attributed to other conditions rather than to the wetting agent. If the wetting agent or the compounds formed are carried over into the plating solution, trouble is most likely to develop. The correct wetting agent may be used in a plating solution but it should be selected for the solution used and not be a product of unknown composition carried over from a solution in which a wetting agent with the wrong characteristics has been used.

Work may be degreased by any of the well known methods previous to racking, or even on the plating racks, which will eliminate the "soaking" unit, provided that the solvent used does not form some insoluble compound with the material that is to be removed. One investigator reports that copper dust which is bound in with stearic acid from buffing compositions, forms insoluble copper stearate in some solvents used in degreasers which is not possible to remove from work in any subsequent alkali cleaner. Care should be used in the selection of the solvent and the inhibitor used. Washing machines are being installed to remove excess grease and "packed-in" buffing compounds. Work must be held more firmly on racks, but that is often an advantage in the plating solution where good contacts are of much importance.

When a "soaking" tank is used, the following water rinse should be hot. A cold water rinse will congeal a soap film on work that may become an insoluble acid soap film if the work is passed through an acid pickle. Such a film will prevent adhesion of electrodeposits especially in nickel solutions unless removed before entering the nickel tank—which is not always possible. Solvent emulsions can be rinsed in cold water but hot water will be better.

Pre-cleaning work in any manner permits work to go directly into the electrocleaning tanks. The word "tanks" is used because it is often advisable to use two electrocleaning tanks, one in which the work is the cathode—the other in which the work is the anode. "Direct" electrocleaning—the term applied when the work is the cathode—is nearly always used first, an exception will be noted later. Compounded cleaners that are well balanced should be used. The ingredients and their proportion depend upon the nature of work being cleaned. Steel or iron require strong cleaners, often too high in alkali for brass or copper alloys without the danger of tarnishing. It is good practice to use the same cleaning compound for steel or brass by regulating the amount of cleaner used for a given volume of solution. Zinc and zinc-base die castings require a very mild cleaner of a very dilute solution of standard cleaning compound.

For cleaning steel or brass, the "direct" electrocleaner can be followed by a "reverse" electrocleaner—i.e. where the work is made the anode. Due to the solubility of zinc in, even weak alkali solutions, which is accelerated when current is applied, it is not advisable to use the "reverse" cleaner. The object of a "reverse" cleaner is to insure cleaning. Greases or buffing compositions may become "packed" in recessed parts. The alkali will remove the grease but leaves the "solids" which are mixtures of abrasive and metallics. When "direct" cleaning is used, the metallics taking on a positive electric charge, adhere to the work. It requires a change of the polarity of the electric current to "drive" off the metallics which, as a rule, carry the abrasive with them by breaking up the "packed" spots.

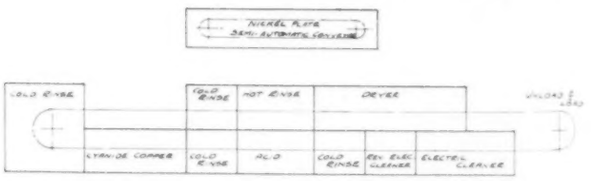


Fig. III. Automatic cleaning and drying unit with semi-automatic nickel plating.

The time of reverse cleaning, especially in brass, must be short,—just long enough to change the polarity of the adhering metal particles, otherwise a heavy tarnish will develop. Steel can receive a longer treatment. It is not advisable to "direct" and "reverse" clean in the same tank, because if the metal being cleaned goes into solution, either chemically or electrochemically, it will be plated out upon the work when direct cleaning is applied and cause stains under the plate or peeling of the subsequent electrodeposit. The electrocleaning is followed by thorough cold water rinsing.

The exception given above to the use of "direct" cleaning is when the same rack is used over again after either zinc, tin or cadmium plating. Zinc, tin and cadmium

are chemically soluble in alkaline solutions. The metal content of the cleaning solution will increase to the point where it will be deposited upon work as a loosely adherent film which, at first, is hardly noticeable and which will result in poor quality of deposit and failures. With a correctly constructed compounded cleaner, "reverse" cleaning can be successfully used. The metal in the cleaner going to the "cathodes" will then do no harm regardless of the amount in solution.

The current density for electrocleaners has never been definitely established. It ranges from 10 amperes to 40 amperes per sq. ft. and this range is not absolute. A current density of 10 amperes for brass and up to 20 for steel is safe and generally applicable. This applies to both "direct" and "reverse" cleaning. A pressure of 6 volts is sufficient. At one time it was thought that 12 volts was necessary. This was mainly due to making the steel tank the electrode. The inside of the tank became coated over with iron oxide and metallic soap which act as insulators and prevent the passage of the current. In an endeavor to overcome this, a high pressure of 12 volts was considered necessary. Since steel, or better nickel, or heavily nickel plated steel anodes have been used instead of the tank, a pressure of 6 volts has proved strong enough. When the steel anodes are perforated, a better distribution of current is had and there will be also an "agitation" of the solution set up that will assist in bringing fresh solution more often to the work. It is probable that the function of the current in electrocleaners is to keep a rapid flow of fresh solution to the work rather than to cause evolution of hydrogen, (which has no detergent properties) to "blast" off the dirt or to cause silica compounds to "bombard" the article being cleaned.

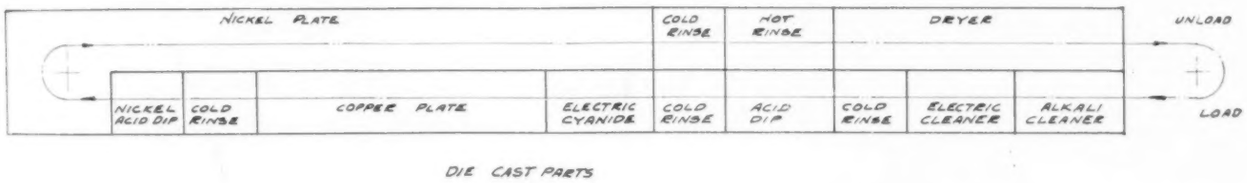


Fig. IV. Full automatic copper-nickel plating unit for plating die castings.

Pickling

It is advisable, and more often, essential to pickle steel and iron after alkali cleaning. Both sulphuric and hydrochloric acids are used, the former can be used with or without current. In England, many use a strong sulphuric acid pickle with current, making the work the anode. A current density of 100 amperes per sq. ft. is considered good practice. Hydrochloric acid is used in this country more than sulphuric acid for pickling previous to electroplating. When sulphuric acid is used, it is generally with current and the work may be the anode or the cathode. Cathodic pickling should not be used for high carbon or alloy steels that may be affected by hydrogen embrittlement. Non-adhesion, blistering or pitted deposits are likely to occur. Often "water-breaks" occur on steel that is immersion sulphuric acid pickled although apparently the work has been well cleaned. This may be due to the heat generated by the contact of the acid film on the work with air and thereby causing the surface to become "dry" and which does not wet well in water. If the work is given a dip into a cyanide solution or an alkali cleaner there will be no "water-breaks" after rinsing. This condition does not occur when hydrochloric acid is used. The outstanding difficulty in pickling steel prior to electroplating is the removal of the slight carbon film left on the steel. With the advent of bright nickel deposits followed directly by chromium plating, the removal of this carbon "smut" would be an advantage in obtaining better deposits. There is no doubt but that research will develop a suitable method to accomplish this. In all probability it is even now being done as electroplaters seldom fail to master essential problems.

The time of pickling need never be more than a minute and often less. The removal of the oxide coating created by welding should be done, if possible, as a separate operation. While it may be done in the cycle of a full automatic the residue at the weld is likely to be the cause of trouble, especially a porous electrocoating.

Zinc and zinc base castings are, as a rule, given an acid dip after alkali cleaning. Weak hydrochloric or hydrofluoric acid is used.

Brass is not put through acids but there is an exception. Brass articles that have been soldered may have a film of lead or tin after being cleaned in an alkaline cleaner. It is advisable to use a hydrochloric acid dip in the cycle previous to the usual cyanide dip. Leaded brass may become coated with a film which should be removed in a weak hydrochloric acid. Sulphuric acid should never be used, as the lead may not be removed but only converted to lead sulphate.

Cyanide Dip

A weak sodium cyanide solution, used with or without current, follows the rinse water after the cleaning or acid dipping. Whether or not the current is applied depends upon the character of the work. In any case, brass should always be cathodically cyanide cleaned—anodic cleaning in cyanide will destroy the lustre of the buffing. Electric cyanide cleaning is more positive than a dip regardless of the length of time of the dipping. Films that form on the work in alkali cleaners as well as tarnish are more readily removed. The soap films, if present, are partially if not wholly removed. Electric cyanide cleaning of steel is practiced and no doubt has an effect which although not as yet clearly understood, gives results that should not be underestimated. Some plater will eventually add a compound to the cyanide cleaner that will remove carbon "smut."

Copper Plating

A warm cyanide copper solution can, if so desired, follow directly after the cyanide solution. In some cases, the cyanide copper solution can be used as a cyanide dip by having a knife switch to cut the current from the tank. It is also practical to place the copper anodes at the end of the tank from which the work is removed and have no anodes where the work enters the solution. In this way,

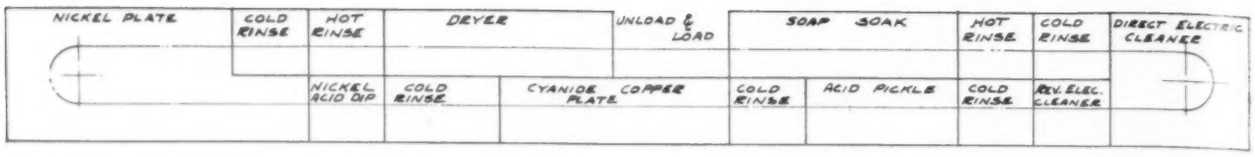


Fig. V. Full automatic cleaning, copper plating, nickel plating and drying unit with center loading station.

the cyanide copper solution has the double function of being a cyanide dip and a copper plating solution. The deposition of copper on iron or steel is not always essential. Good adherent nickel deposits can be had without a copper undercoat. It is often used and acts, no doubt, as a final "cleaner and plater."

Cast or leaded brass should be copper plated lightly especially if they are to be chromium plated after nickel plating. Lead does not alloy with brass and exists in a dispersion throughout the metal. Lead is not easily directly plated with nickel as there will be a weak bond. In fact, the lead may become sulphated before the nickel covers it and the result will be blisters or peeling of the nickel coating. Copper cyanide solutions are necessary to cover the lead and nickel will readily cover copper. It is essential, however, that the alkali either bound up in the deposit or that which exists as a film on the work be thoroughly neutralized before putting the work into the nickel solution. That is to prevent any chemical reaction at the surface of the work when it receives the nickel deposit. Either non-adherent deposits that will show up upon being chromium plated, or porous nickel coatings due to the inclusion of nickel hydrate will be the result.

Nickel Neutralizing Dip

Any work that is passed through a cyanide solution, no matter how well rinsed with clean water, should be put through a neutralizing dip previous to nickel plating. That is good insurance against trouble. A nickel solution of the same composition as that of the plating solution can be used by increasing the degree of acidity—the pH value. In the use of a nickel solution of pH of 5.8, a pH of the dip of about 5.0 is employed. The work is put directly into the nickel solution after the nickel acid dip. If the pH of this dip is closely observed it will be possible to keep the pH of the plating solution at a fairly constant value by the "drag-out" from the nickel acid dip. Even when nickel solutions of lower pH values are used, it is well to use the nickel acid dip.

The foregoing story has dealt mainly with the preparation of work for nickel plating. The same general cycle, except the nickel acid dip, applies to the cleaning of work previous to copper, brass, zinc, tin or silver, cadmium, solutions. The exact cycle depends upon the nature of the work to be processed and the character of the desired electrodeposit. The cycle for chromium plating nickeled work is quite simple, consisting only of one electric cleaner, a cold water rinse, an acid pickle, another cold water rinse previous to the plating solution. The cycle for cleaning nickel silver flatware—e.g. spoons, forks, etc. would include the silver "strikes."

The type of each plating solution can be determined only by the requirements of the class of work produced.

Recovery of Drag-Out

The tank following the plating solution can be a "recovery" tank or a regular rinse. Recovery tanks after gold and silver solutions have been used in a general way, in many places as a source of profitable recovery. The "recovery" solution is used, as a rule, to replenish the "drag-out" and evaporation of the plating solution. This has been the general practice in chromium plating. In a previous paper, the loss in dollars and cents by "drag-out" was shown. It was also stated what has been done in one plant with the "drag-out" from a gold solution. It is known that in some silver plating plants the solutions in the recovery tanks are, at stated periods, run into a sump and the silver precipitated by additions of acid. Would it not be more economical if some simple method was devised by which the metal itself could be recovered rather than the salt of the metal that requires further treatment for recovery?

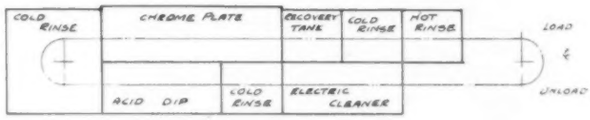


Fig. VI. Full automatic chromium plating unit.

In a convenient part of the tank where there would be no interference with the handling of work, an anode and a cathode rod can be placed within a few inches of each other. These can be connected with the generator for the cleaning cycle or the generator for the plating solution as the available current permitted. On the anode rod, hang suitably sized hard gas carbon plates. For cathodes, use worn anodes that have been well cleaned so that any metal deposited on them will adhere. If necessary install a rheostat so that there will not be an excessive amount of current. Maintain this unit alive during the plating operations. While it must be determined whether this method will be economical for nickel, brass, copper or zinc it certainly will be for cadmium, gold and silver. At times it may be necessary to either discard the solution or recover the metals by precipitation or evaporation due to a condition in which the work will be stained. Whatever metal is recovered may be sold at a higher price as scrap; or, if in a good condition, used as anodes in the plating solution.

Automatic plating units mean not only increased production at lower costs but better and cleaner plating rooms in which the health hazard is materially decreased. The operation and the control of large plating solutions is easier than with several small solutions which means better plating with less rejects. The plater is released to maintain production rather than to nurse headaches.

PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Technical Advisor For June Issue

G. B. HOGABOOM, JR.
Consultant in Electroplating and Metal Finishing, Newark, N. J.

When sending solutions for analysis please give following information: name and address; class of work being plated; kind of solution and volume; length, width and depth of tank; temperature of solution; current density, cleaning sequence and any other pertinent facts.

Full information is necessary in order to render proper service.

Analysis of Boric Acid in Nickel Plating Solutions

Q. In attempting to determine boric acid in my nickel plating bath, I encounter the following: I take 5 cc. sample of my nickel bath and add 200 cc. of water then I add 50 cc. of 0.5 N. sodium hydroxide to this, then I filter and save the filtrate. To the filtrate is added a few drops of methyl orange, and then it is neutralized by adding exactly 50 cc. of 0.5 N. HCl, 5 cc. of glycerin and 1 drop phenolphthalein indicator are then added, and I have a red, pinkish color. Inasmuch as I am supposed to titrate with 0.1 N. sodium hydroxide to a permanent pink end-point, I don't see how I will be able to do this when it is already pink before I start.

Will you please throw any possible light on this for me?

A. The procedure as outlined is not satisfactory for many reasons. In the first place, some of the sodium hydroxide is removed by combination with the nickel. It is, therefore, necessary to add less than 50 cc. of hydrochloric acid. The exact amount necessary is added by noting when the color just changes from pink to orange which is the methyl orange end-point. A larger amount of glycerin should be added, say 25 cc. This should be neutralized first because glycerin is usually slightly acid. Sufficient phenolphthalein should be added to give sufficient color to the solution at the end-point. About 6 to 10 drops are required. If these precautions are followed a fairly satisfactory analysis may be made although the accuracy is limited by the difficulty of getting a sharp end-point due to the masking effect of the methyl orange.

A better procedure is to decolorize the solution by adding sodium cyanide solution slowly to the sample of nickel bath until the precipitate of nickel cyanide which first forms is just completely dissolved. Then add the methyl orange and titrate with the hydrochloric acid until the color changes from yellow to orange. Add the glycerin and 1 cc. of bromcresol purple indicator (used in comparator sets for pH determinations) and titrate with the sodium hydroxide until the color changes to a dark green and finally to a purple. Using bromcresol purple, the masking effect of the methyl orange color will not be noticeable. Decolorizing the solution with cyanide obviates the inconvenient filtration and washing.—G. B. H. Jr.

Wear Resistant Verde Finish on Sheet Copper

Q. We have several large lanterns to be finished in verde green, preferably a deep color. Will you furnish us with information as to how we can produce a verde finish on sheet copper or sheet bronze, which will not wash off with water, as the lanterns are to be used outdoors. We prefer a solution to be painted on with a brush as the pieces are very large and are not suitable for immerson in tanks.

A. A pleasing green color or patina may be produced on sheet copper by a method developed by the Copper & Brass Research Association. 420 Lexington Ave., N. Y. City, and described in one of their leaflets. When properly produced, this patina is somewhat more blue than the natural color of weathered copper. Exposure to the weather softens this color and a durable film develops on the metal. This patina can be produced on copper and with some degree of success on the rich low brasses or bronzes but does not develop on the high zinc alloys.

Before applying the coloring solution, the lanterns should be thoroughly cleaned to remove dirt, grease, etc. This can be done with any of the cleaners sold especially for removing

grease and oil from metal. All stains from excess soldering flux should also be removed. This cleaning should be followed by a thorough rinsing with water. After the metal is clean, the lanterns should be exposed to the weather for a few days to develop an even tarnish.

The coloring solution is inexpensive and easy to prepare. The formula makes a quantity sufficient for about 750 sq. ft. of metal.

Ammonium sulphate (tech. grade)	4½ lb.
Copper sulphate (blue vitriol)	2¼ oz.
Concentrated ammonia (spec. grav. 0.90)	1 fluid oz.
Water	5 gal.

The ammonium sulphate and the copper sulphate are dissolved in the water and when solution is complete, the ammonia is added with stirring. This coloring solution is quite stable and may be kept on hand for future use. In preparing or storing this solution, metal containers must not be used; glass, crockery or wood is satisfactory.

The final appearance of the patina depends largely upon proper application of the coloring solution. This is best done by spraying and for this purpose a small garden sprayer is quite satisfactory. The inside of the can should be protected with some sort of asphalt paint. A light gentle spray should be used so that fine isolated droplets form on the surface. About five applications are necessary, 20 minutes apart to allow time for each spraying to dry. This is important because too heavy an application will cause runs or streaks on vertical surfaces. This procedure will produce a film of salts distributed rather evenly over the metal surface.

This layer of salts slowly attacks the metal and develops the patina from the metal itself. This requires that the coated article be kept for about 6-8 hours in some place where the humidity is 80% or higher. The dampness keeps the film moist and the chemical attack proceeds. It is sufficient to expose the articles outdoors to fog or overnight so that dew may form on them. Exposure to a direct water spray such as rain, however, will wash off the salts and failure will result. After the articles have been exposed as above, they should be washed directly with water or put out in the rain to remove the surplus salts. The patina as developed should now withstand any further exposure to the weather. It is suggested that a few preliminary trials be made on some sheet copper before the lanterns themselves are treated.

Normal Solutions

Q. I would greatly appreciate a clarification in preparing standard reagents and the mathematics involved. According to my calculations a normal solution of HCl requires 93.3 cc/L (of the 39.11% HCl). According to the figure issued in Platers' Guidebook it is 83 cc/L. How did the authors obtain this figure?

As I understand or rather as I have been taught chemistry, a normal solution is the equivalent weight of the active element of a substance dissolved in 1000 cc. of water. That being the case, how would you prepare a normal solution of iodine (I_2) when I_2 is insoluble in water? I came to the conclusion that (KI) can be used as a medium and then dissolving the I_2 into the KI solution but that in my opinion wouldn't be a normal solution, inasmuch as I_2 would not be the active element.

Again, silver nitrate ($AgNO_3$) according to my figures would possess 169.888 g/L (normal). Would this be correct? As my figures differ somewhat with those of the Platers' Guidebook, would you please inform me as to the quantities in preparing normal solutions for sulphuric acid and sodium bisulphite.

A. You are correct in your calculations that to make a normal solution of hydrochloric acid, 93 cc's per liter should be used instead of 83 cc. as mentioned in Platers' Guidebook; 83 is a typographical error. However, the use of 83 cc's per liter will not entail any difficulty inasmuch as the solution is standardized. 17.0 grams per liter of silver nitrate are used to make a 0.1 normal $AgNO_3$ solution instead of the theoretical quantity 16.989 because the silver nitrate used is not 100% pure and the resultant solution will be nearer to 1/10 normal when 17.0 grams are used.

For preparing a normal solution of sulphuric acid, one-half the molecular weight is used, namely 49 grams per liter.

The normality of sodium bisulphite depends upon the reactions which sodium bisulphite will undergo in the analytical procedures.

In making a normal solution of iodine, it is entirely correct to use potassium iodide which need not be considered in calculating the normality inasmuch as it does not take part in the reaction. You are wrong in your assumption that the proper amount of iodine dissolved in a potassium iodide solution would not be a normal solution, because the iodine would be active inasmuch as there is no definite compound formation between KI and the iodine, and all of the iodine dissolved is available for chemical reaction.—W. R. M.

Chromium Plating on Brass

Q. We have a customer who would like to chromium plate directly on brass stampings. Is it possible to use a copper cyanide flash before chromium plating?

A. Brass, copper, and zinc alloys should never be chromium plated directly because the chromium will crack in a very short time, resulting in staining, and often flaking of the coating. The failure of chromium coatings on brass has been attributed to the differences in coefficients of expansion between the chromium and brass. However, we do not believe that this is the major reason for the development of cracks, but rather the failure is due to the relatively low adhesive bond and tensile strength of the brass, which is not sufficient to prevent the high stresses present in the chromium deposit from resulting in cracks. A nickel undercoating, however, is sufficiently strong to prevent this cracking and for very mild exposure should be at least .0003" thick and for severe exposures, should be .0008" thick.

—W. R. M.

Sulfur-Free Paper

Wrapping paper containing small amounts of sulfur may cause spotting on copper or silver finishes.

The paper may be tested by wetting it with distilled water and pressing it against a freshly buffed, clean silver plate using a glass plate as a cover. If no black spots appear on the silver in 48 hours, it is safe to use.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—F'NISHING—RUST PROOFING—LACQUERING

A Resume of Lead Plating

Joseph B. Kushner, Ch.E.

Lead, the soft, ductile, bluish grey metal of the tin group was probably first electrodeposited by Becquerel[1] in the early eighteen-forties.

Its appearance and properties are such as to render it unfit for decorative purposes in metal finishing; its commercial use in electroplating is, therefore, limited to the field of corrosion protection. Its chemical and physical features in this respect are quite interesting. Lead is resistant to the non-oxidizing acids such as cold HCl, HF and dilute H_2SO_4. It is attacked, however, by oxidizing acids such as HNO_3 and certain of the organic acids, notably acetic. In air, lead forms a slight oxide film which protects the underlying metal from further oxidation. Unfortunately, lead's position in the electromotive series is so low (single potential 0.12 volts[2]) that its protective action on a basis metal such as iron, cannot be termed "sacrificial" in the sense that it corrodes preferentially to the underlying metal. On the contrary, it is cathodic to iron and will cause that metal to rust more readily if the lead plate is at all porous, cracked or worn away.

In this connection, recent work of Hay[3] has shown that a lead deposit will protect iron and steel from atmospheric corrosion indefinitely if it is at least 0.02 millimeters (0.0008") thick. Kurrein[4] claims that 34 grams of lead plated over 1 sq. meter of surface is sufficient to pass a porosity test. This latter writer's figures would indicate that a thickness of only 0.003 millimeters (0.00012") is sufficient. If the hardness of a metal is taken as a measure of its wearing qualities, these minimum figures quoted above must be considered slightly optimistic, for if the lead plated object is exposed to any abrasion or wear, a coat of this thickness would soon disappear (the Brinell hardness of electrodeposited lead is 3-5[5]!). A more likely thickness for protection of underlying ferrous metals would be in the order of 0.2 millimeters thick (0.008").

Luckily, such heavy deposits of lead are not too difficult to produce. Its specific gravity being high (11.3) and its valence as deposited, low (2), the electrochemical equivalent of lead is 0.14 ounces per ampere-hour. In some of the modern baths, current densities of 50 amperes per sq. ft. can be obtained, which means that 0.0025" per hour can be deposited, assuming 100% cathode efficiency.

Lead is not extensively electroplated because the low melting point of the metal (327°C) makes it possible to use a hot dipping process for depositing it on other metals. Molten lead will not deposit directly on iron but if the lead is alloyed with tin (10-20%), an alloy called "terne" is formed which readily coats the iron. Lately, however, there has been a decided trend towards the use of electrodeposited lead for many purposes. The new types of baths permit rapid deposition of the metal and as is pointed out by Belyaev and Birman[6], lead plating is superior to lead dipping as objects can be stamped, machined and formed without distortion. Another advantage is that pure lead can be deposited directly upon steel and iron without the use of tin. A third advantage, pointed out by Kurrein, is that there are little or no stresses present in an electroplated coating whereas in dipped coatings there is a contractile stress (3.5% shrinkage).

Suggested uses[7] for lead plating are:

1. The protection of ferrous or other metals from corrosive liquids.
2. Coating of iron flues where dilute sulphuric acid is condensed.
3. Lining of brine refrigerating tanks.
4. Coating of chemical apparatus.
5. Lining of metal gas shells.
6. For plating apparatus used in viscose industry.

Lead can be deposited as an alloy with other metals, such as tin, bismuth, copper, antimony, silver. Perhaps in this way, lead plating may find its widest uses. A contemporary paper decribes its possibilities as a bearing alloy component when plated out with silver from a tartrate, silver cyanide bath[8] (4% Pb in the deposit).

Lead has been electrodeposited from many types of solutions; for example, electrolytes containing: oxalates, acetates, lactates, plumbites, cyanides, nitrates, hydrofluosilicates, hydrofluoborates, perchlorates, dithionates, not to mention organic complexes such as the sulphonated phenols, and even liquid ammonia and formamide. Most of the writers who have proposed these baths have claimed to obtain fine, dense, adherent deposits of lead from them, but practically and commercially, only four of these have stood the test of time and use.

A fifth of recent origin is relatively new in this country and has yet to be tried on a large scale. They are described below.

I. *The Hydrofluosilicate Bath*

This type of bath was first described by Leuchs[9] in 1886 but was commercially developed by Betts[10] in the early part of the twentieth century. A typical formula as given by Reeve[11] and Koehler[12] is:

$PbSiF_6$ (lead fluosilicate)	24	oz./gal.
H_2SiF_6 (hydrofluosilicic acid)	3.9	"
Glue	0.53	"

Temperature 35°-38° C (95°-100°F.). Current density 46.5 amps./sq. ft.

A more recent bath, recommended by Krause[13] contains:

$PbSiF_6$	82.5	grams/liter
H_2SiF_6	70	"
Gelatin	0.01	"

Current density 1 amp./sq. dm. Voltage 0.15 to 0.2 volts.

II. *The Hydrofluoborate Bath*

This type of bath has had a history similar to that of the bath given above inasmuch as it was first suggested by Leuchs and made practicable by Betts. A formula given by Blum and Hogaboom[14] from an original paper of Blum and co-workers[15] is as follows:

Basic lead carbonate	20	oz./gal.
50% hydrofluoric acid	32	"
Boric acid	14	"
Glue	0.025	"

Specific gravity = 21° Baume. Current density 10-19 amps./sq. ft. to double this amount, in more concentrated solutions, with rapid agitation (mechanical, as air agitation oxidizes the lead). Use at room temperature. Current efficiency approximately 100%.

A solution of this type is recommended for brush plating by V. P. Fedotieff and co-workers[16]. Good deposits are obtained with from 20 amps. per sq. decimeter (185 amps./sq. ft.) upwards, it being claimed that at the higher current densities it is possible to deposit 0.1 mm. of lead in 30 minutes.

(To be concluded in July issue)

Post Scripts

It seems to be a popular sport nowadays for people to spend a day or a week in a foreign country and return to write a book on the "foreign" situation or give lectures to bridge clubs on the menace of this or that national policy (usually preconceived) observed during the meandering.

The impressions of America as reported by Messrs. *H. Hignett, Raper* and *D. Stockdale* before the British Institute of Metals are both interesting and amusing, but, however, do not fall in the abovementioned category. Dr. Stockdale began his journey, anti-American, was converted and returned to England strongly pro-American. The following statement by Mr. Hignett, "Even American boasting became tolerable and, indeed, admirable, for it was born of an enthusiasm which must be refreshing to the most taciturn Briton" —seems to show a real understanding. Perhaps America is being re-discovered.

•

Ernest Lamoureux reports that the Los Angeles Branch of the A.E.S. is making plans for their 1940 annual meeting to be held on March 30, so that Eastern members will have time to save their pennies to attend.

•

Men are peculiar. For instance, a fellow who hadn't kissed his wife in five years shot a fellow who did.

•

Austin Fletcher of Binghamton, is the proud daddy of a little daughter who will add to the liveliness of the Fletcher household already engendered by two lively youngsters.

•

Willoughby Sheane contributor to M. I. and G.E. organic finishing expert, will give a series of lectures on organic finishing at the summer Industrial Chemistry course of the Bridgeport Engineering Institute. "Bill" is an alumnus of R.P.I. and Carnegie Tech.

•

Harold Faint, formerly with Divine Bros., Utica, N. Y., on June 1st became Sales Manager for the Continental Roll & Steel Foundry Co. of East Chicago, according to C. S. T. They are to make a full line of buffing and polishing machines. *B. F. Bower* will become Chief Engineer for Continental.

•

Notes at Milwaukee's Annual Meeting

When that "Heine" band gets going neither "hell nor high water" or tired feet can keep *Jake Hay* off the floor—add *Walter Pinner* to the Beau Brummel list of the A.E.S.—*Bob Steuernagel* ranks with N.T.G. for picking beautiful dancing partners.—*Bill Kennedy* says he doesn't dance because he was born with two left feet.—*George Hogaboom* and *Gustave Klinkenstein* continued their "battle of colors" at the educational session.—*Harold Smallman* certainly doesn't live up to his name.—What's the goal, Harold—300 lbs?—Shame on you, *Phil Ritzenthaler*, talking plating all the time rather than dancing with your charming wife during the "dancingest" music.—*Oscar Servis* was on hand to see how Milwaukee's party compared with Chicago's recent meeting. Oscar will soon receive a substantial award for his faithful 40 years of plating with the Felt and Tarrant Co.—*Dan Wittig* was present casting his fatherly eyes over the proceedings.

•

Horace Smith, the Grover Whalen of the Asbury Park Convention, had to recently give up wearing a belt and go to suspenders as his hips have disappeared due to muscular development amidships. "Anyway," said Horace, "I got more room for expansion."

•

We are still trying to find out what herbinium plating is. A special double "Mickey Finn" will be awarded free to the instigators of herbinium plating.

•

I am glad to know that our editorials are sometimes read and even used to advantage. *Clarence Helmle* pointed out a slip of words in the May editorial on "Crystallization of Metals" in the statement —". . . when mechanized parts are to be designed for long life, they should be constructed with tensile strengths considerably above the elastic limit." What I meant to say was—"with tensile strengths considerably above the limits of applied stress." We were also called to task for publishing an ABC ad mentioning that electricity is sold by the kilowatt rather than kilowatt hour. Our readers have sharp eyes.

•

E. A. Sesselmann, Waterbury representative of American Cyanamid & Chemical Corp. underwent an operation in the hospital some time ago. A pretty nurse tended to his wants before undergoing anesthesia, and I guess the last thing he noticed before entering the land of nod, was her

Part of the gang that attended Bob Leather's recent party at Leacrest. Some of the faces we recognize reading from left to right are: Fred Gotthardt, Adolph Grele, Jack Gormley, Clarence Helmle, Jack Barry, George Knecht, Elmer Munson, Axle Boggild, Horace Smith, Joe Downes, Oliver Sizelove, Bob Leather, Tom Trumbour, Lionel Cinamon, Carl Huessner, Herman Braun, Dr. Kellner, Jess Whitney, Oscar Stocker, Charles Koelbl, Eugene Phillips, Clarence Tucker and Paul LaLonde.

reassuring smile. A Chinese nurse was assigned to watch him as he came out of the ether and on gaining semi-consciousness he noticed a stolid oriental face staring at him instead of the pretty nurse. "Gosh," muttered Sesselmann, in alarm, "they've taken me to China and I've a date to be in Hartford in two weeks."

•

Take Yo' Pick

Rastus and Liza were married on Christmas day and the following night he came home with a washboard, a big wash tub and a three-foot mirror.

"What's all dat truck you bring?", asked Liza.

"It ain't truck," replied Rastus, "an' you kin take yo' pick. Yo' take de washboard and tub and go to work, or yo' kin take de mirror an' set down an' watch yo'self stahve to death."

•

Trumbours Celebrate 35th Anniversary

Mr. & Mrs. T. A. Trumbour.

Mr. and *Mrs. Thomas A. Trumbour* will celebrate their 35th wedding anniversary during the Asbury Park Convention of A.E.S.

Tom has been with METAL INDUSTRY for the past 38 years. He is the only member of the A.E.S. who has attended every convention since 1912. At present, Tom is business manager of METAL INDUSTRY and permanent secretary of International Fellowship Club.

•

Newark, the home city of the sponsor of the 27th Annual A.E.S. Convention has many notable "firsts" to its credit according to G. B. H. Some of them are:

First Generator — **Edward Weston**, designer.

Looks as if the boys have a tough problem to solve. Clarence Tucker of Eagle Lock Co., Terryville, Conn., on left; Fred Gotthardt of Magnuson Products Corp., reaching for the horseshoe; "Champion" Ed. Charleson of Yale & Towne Mfg. Co., scratching his head, and "Inventor" Axle Boggild of G. E. putting in his two cents' worth.

First Use of Boric Acid in Nickel Solutions—by Edward Weston.

First Measuring Instruments for Current and Voltage—by Edward Weston.

First Tripoli Composition—came as a result of Mr. Van Winkle's trip to diatomaceous earth deposits in Missouri in 1880.

First Plating Barrel—used by James Morehouse in 1902.

First Clear Lacquer—by Zapon Co.

First Cast Nickel Anodes—used about 1870.

First Class in Electroplating—by James Morehouse in 1898.

First Supply House—H-VW. Co.—124 years ago.

If you have "firsts" preceding these, write us about them.

•

Cabbages and Kings

The view from the foot of Wall Street near the East River is one of the most impressive in N. Y., with the highest concentration of humanity per sq. ft. in the world. The giant modern skyscrapers dwarf adjacent old shacks, rat-infested buildings and fish markets. Brokers, executives, stevedores, clerks and bums promenade at noon hour on the Wall Street dock watching the never-ending stream of boat traffic pass up and down the East River. Liners and freighters pass to Europe, the Orient or South America. There goes the Santa Barbara to Chile, the steamer to the World's Fair, the Oriente to Havana, the Borinquen to Puerto Rico, and with a longing look, the cabbages and kings stroll back to work. A "king" throws his Wall Street Journal away and it is promptly appropriated by a "cabbage," the flotsam and jetsam of humanity. The paper is carefully examined and after the "king's" woes have been digested, he goes back to work.—"Say, buddie, can you spare a dime for a cup-a-coffee?"

Philip Sievering expects to have at the Convention, a sample of steel nickel plated 67 years ago at the Boston Nickel Plating Co. by *Mr. Taylor.*

•

The following epigrams have been contributed by *Walter Barrows.*

The upkeep of some women is costly. They spend half their lives in a beauty shop for repairs.

Time will heal a lot of things, but it won't heel a shoe.

Paint beautifies a fence much more than it does a face.

The plater who keeps one eye on the clock and the other on the foreman will never get promoted.

It takes the wife of the life of the party to make him feel like "30 cents."

An expert is a man who can do anything properly until he has to do it.

No woman ever has enough to wear, and she wouldn't wear enough if she had it.

A perfect husband is one who married a wife.

Most men like to argue about some things they know nothing about.

The little girl who used to make mud pies has grown up and daubs her face with beauty clay.

A man of few words . . . any married man.

The best way to make things come your way is to go out and get them.

Our worst troubles are those never encountered.

See you at Asbury Park.

Walter R. Meyer

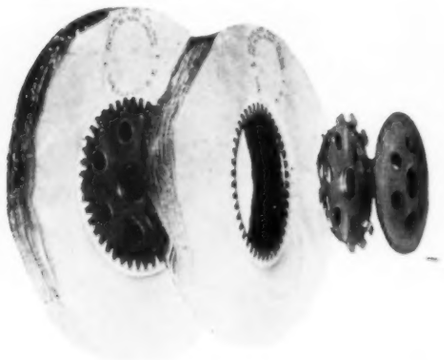
NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Ventilated Buffs

MacFarland Manufacturing Co., Inc., 21-03—41st Avenue, Long Island City, N. Y., have announced the development of a new ventilating center for various types of conventional buffs. This ventilating center consists of perforated hubs and flanges, which draw in the air forcing it through the various sections of the buff.

There is no additional cost in providing for ventilation over the standard or so-called conventional type.



Above illustrates assembly of center plates and flanges in all types.

Definite reductions in temperature of operation have been recorded, and this new ventilating system, it is claimed, will eliminate burning and increase the buff-life, with a saving of at least 25%.

The ventilating centers permit ventilation with full disc buffs and all grades and types of sewed pieced buffs thus enabling savings to be accomplished by efficient performance due to the proper high peripheral speed.

Broad claims covering an air-cooled buff having means for the admission of air through the sides of the buff have been covered by U. S. patents.

Licensed jobbers and distributors are being appointed, and for further information inquire of the MacFarland Mfg. Co., Inc.

New Aluminum Coating

A new aluminum coating, which can be applied by dipping or spraying, has been developed by the Special Chemicals Corporation, 30 Irving Pl., New York City.

The material, which is claimed to have a beautiful, silvery finish, adheres to all metals, glass, gutta percha, etc., and can be bent or formed without cracking or peeling. The only equipment required is a baking oven and a spray gun or dipping facilities.

Some of the claimed features are:

Cost less than electroplating.
80% of the reflectivity of silver.
Flexibility with hardness.
Non-peeling or flaking.
Tarnish and rust resistant.

Laboratory tests it is claimed have shown that a single dip will withstand a salt spray of 196 hours on cast iron and 72 hours on rolled sheet steel.

For further information inquire of Special Chemicals Corporation.

Twin Filter Respirator

Willson Products, Inc., 267 Thorn St., Reading, Pa., has announced a new low-resistance twin filter respirator for protection against both Type A and Lead Dusts. It bears Bureau of Mines Approval No. 2127 and is the tenth Willson respirator to be officially approved by this Federal agency under Schedule No. 21.

This respirator, designated as No. 752L, employs a small rubber, form-fitting face piece so designed as to permit the wearing of goggles or spectacles without visual interference. Two Rotiform Filters, each with 30 sq. in. filtering suface, minimize breathing resistance.

The manufacturer will gladly furnish complete information, descriptive literature and prices upon request.

Twin filter respirator.

Galvanizing Powder

American Solder & Flux Co., Wayne Ave. & Berkley St., Philadelphia, Pa., has announced the development of Amco galvanizing powder, which is said to produce a protective surface that is equal in corrosion resistance to that produced by the hot-dip process.

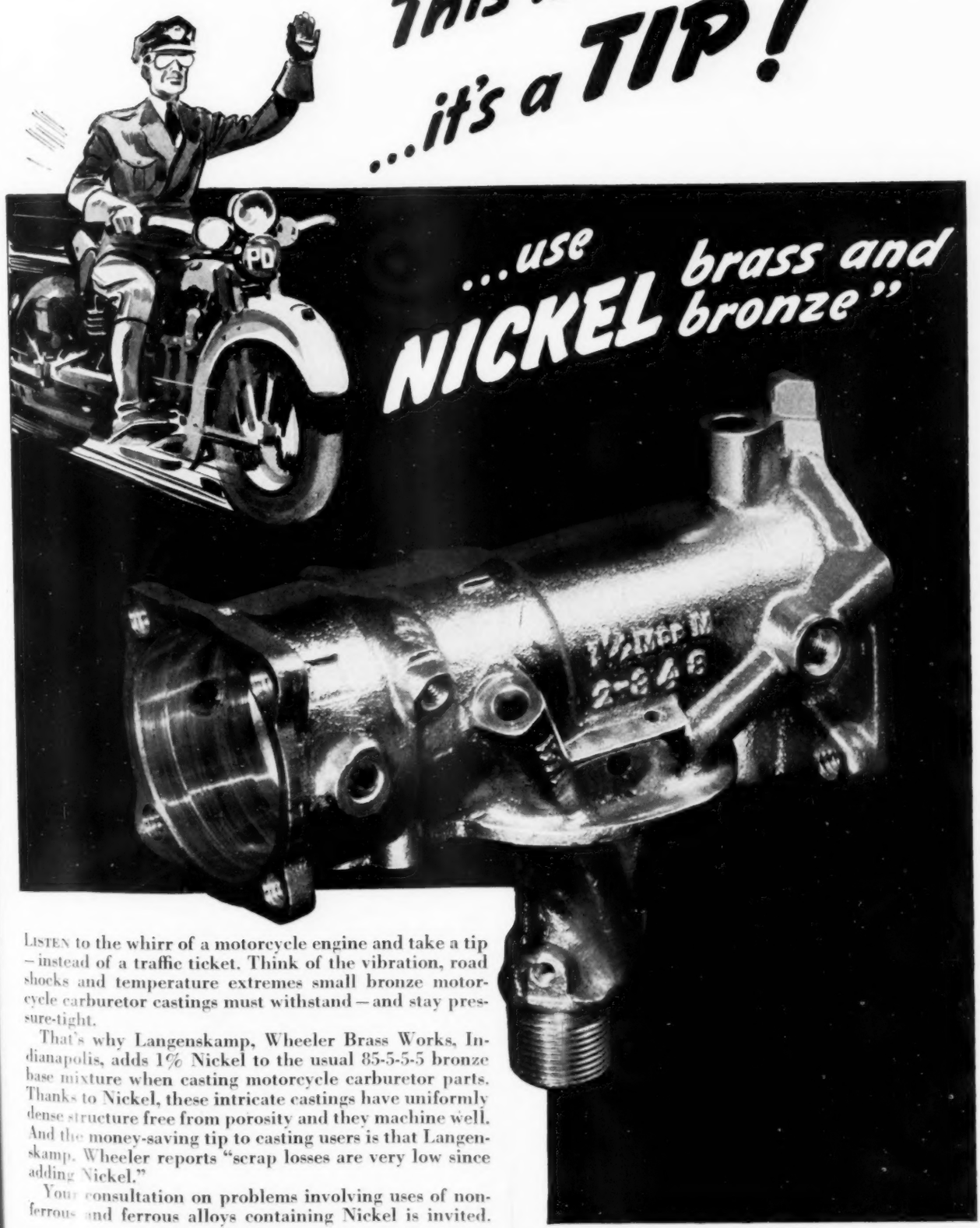
The coating is bonded to the basis metal and is claimed will not chip or flake and the coated metals may be bent, buckled or dented without damaging the protective coating.

The galvanizing powder is specifically made for repair work where it is not practical to hot-dip, and is therefore, not a substitute for original galvanizing. The galvanizing powder is simply used by covering the surface with the powder either dry or in a paste form and then heating. The latter is claimed to be a perfectly continuous and highly protective surface, comparable to the original galvanizing. Because of the fluxing nature of the galvanizing powder, no preliminary cleaning or acid pickling is necessary except where gas welding has formed a highly oxidized surface. The galvanizing powder is recommended for coating the threads of conduit, pipes, tanks, welded joints, fences and any other steel object which cannot be suitably dip galvanized.

A descriptive folder will be sent by making inquiry to the American Solder & Flux Company.

Welded "T" joint. Left, uncoated. Right, zinc coated.

"This isn't a Ticket... ...it's a TIP!



LISTEN to the whirr of a motorcycle engine and take a tip—instead of a traffic ticket. Think of the vibration, road shocks and temperature extremes small bronze motorcycle carburetor castings must withstand—and stay pressure-tight.

That's why Langenskamp, Wheeler Brass Works, Indianapolis, adds 1% Nickel to the usual 85-5-5-5 bronze base mixture when casting motorcycle carburetor parts. Thanks to Nickel, these intricate castings have uniformly dense structure free from porosity and they machine well. And the money-saving tip to casting users is that Langenskamp, Wheeler reports "scrap losses are very low since adding Nickel."

Your consultation on problems involving uses of nonferrous and ferrous alloys containing Nickel is invited.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Elevator Type Full Automatic Plating Conveyor

A distinctly new type of full automatic plating conveyor has been perfected by the Hanson-Van Winkle-Munning Co. of Matawan, N. J., manufacturers of electroplating equipment and supplies. This machine called the Elevator Type Conveyor, is suitable for almost any of the wide variety of plating and coloring operations, including basket cleaning, bright dipping, acid pickling, liquid caustic dips, combination cleaning and burnishing in perforated cylinders, barrel plating and rinsing, paint dipping, lacquer dipping, bonderizing and all classes of electroplating.

The conveyor is of the dwell type, having carriers mounted in their own guides, moving freely up and down. The guides are permanently attached to chains top and bottom at fixed spacings. The carriers advance one station whenever the conveyor chain moves forward the distance of the carrier spacing. A counter-balanced elevator, sliding on vertical guide tubes, moves up and down through a fixed distance, engaging the carriers at the transfer points. During the top position of the transfer the horizontal chain moves forward one carrier spacing before the elevator is lowered.

The outstanding advantages of this conveyor are its simplicity, low headroom and wide range of applications.

Regardless of the number of treatments in the cycle, there is only one lift—the elevator. In principle, it operates like any elevator, having a counterbalance to offset the load of both elevator and lifted carriers. Light loads or heavy loads work equally well with any height of lift.

It is designed to operate by any of three methods:

1. With hydraulic cylinders to raise and lower the elevator—and a geared motor to drive the conveyor chain and advance the carriers from station to station. In some applications, a horizontal hydraulic cylinder will replace this motor drive.

2. With crank and connecting rods rotating through 360 degrees in raising and lowering the elevator. Part of the crank travel is utilized to operate a lever that moves the chain forward thus advancing the carriers from station to station.

3. With a gear driven chain and sprocket drive to raise and lower the elevator and a separate drive geared to the forward drive chain to move the carriers from one station to another. Both drives are synchronized.

In high speed plating solutions, the racked work may be kept in constant motion by oscillating back and forth, permitting use of high current densities. Treatment times may be varied and still maintain a fixed transfer time.

Fig. 1 shows the end view of a bright dip conveyor with a basket being transferred, and about to be lowered. During the next transfer it will advance to a similar position on the opposite side of the conveyor. The transfer time in this conveyor is four seconds; the dwell time, ten seconds; production rate, one basket every 28 seconds. This capacity can be doubled by filling the vacant guides in the machine with carriers, which, as shown, are used only in every other guide. Fig. 2 shows a side view of the same machine with the carriers being lifted by the elevator.

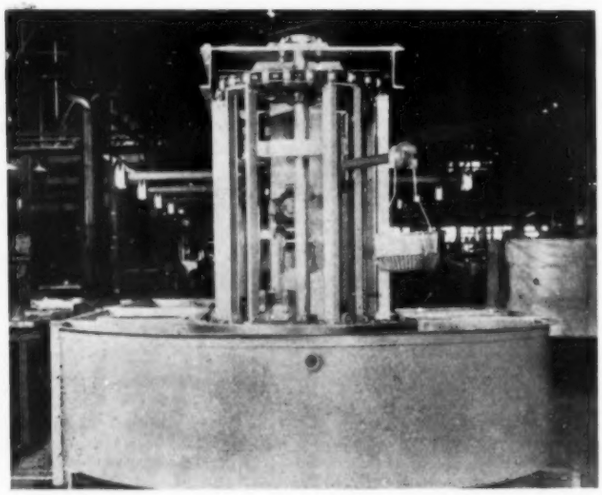


Fig. 1. End View of a bright dip conveyor. Basket is being transferred and about to be lowered.

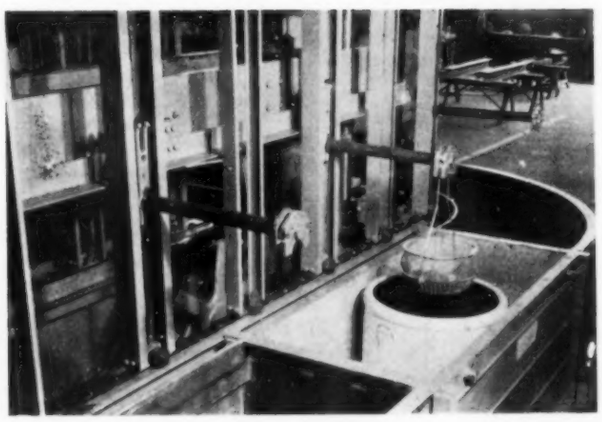


Fig. 2. Side View. Carriers being lifted by the elevator.

Airway Ventilated Buffs

Jackson Buff Corporation, 21-03—41st Avenue, Long Island City, N. Y., report that their airway ventilated buffs using the patented hub ventilation, have resulted in savings of from 50% to 100% due to the elimination of burning and the faster cutting action inherent in these buffs. All of the cotton fabrics in these buffs are cut on the bias, therefore, do not ravel, making a very clean wheel to operate; also require no raking, thereby resulting in a saving of compound which is further augmented by the lower operating temperature of the buff.

Airway ventilated buffs showing parts.

This lower operating temperature is also contributory to a marked increase in the life of the buff, in addition to the value of the bias construction of the material.

For further information on the airway ventilated buff, inquire of the Jackson Buff Corporation.

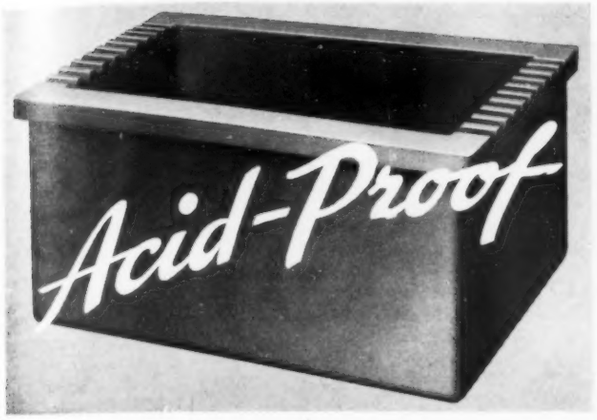
New Baking Metal Finishing Material

Duotone, a new baking metal finishing material which is said to meet industrial utility, economic and appearance demands, has been announced by The Glidden Company.

Designed specially for use on various gradings of metals, it produces a uniform two-tone effect in one spray application.

The new product is available in a wide variety of colors applicable to a wide diversification of production.

Advantages claimed by the manufacturer for Duotone are:



You have the problem

GENERAL CERAMICS ACID-PROOF STONEWARE

has the answer

The every-day problems encountered in the handling of acids and chemicals for electro-plating, galvanizing and pickling can be met . . . once and for all . . . by the use of General Ceramics Chemical Stoneware.

For, unlike other materials, General Ceramics Stoneware is acid-proof through and through . . . is impervious to any pickling bath or plating solution, no matter how strong or how hot.

Whether you need a single dipping basket or a complete pickling or plating installation, engineers of the General Ceramics Company will be glad to help you select the equipment that will best solve your particular problem.

Write for detailed information about the complete line of General Ceramics Stoneware Plating and Pickling Tanks, Dipping Baskets, Silver Baths, Storage Jars and other equipment.

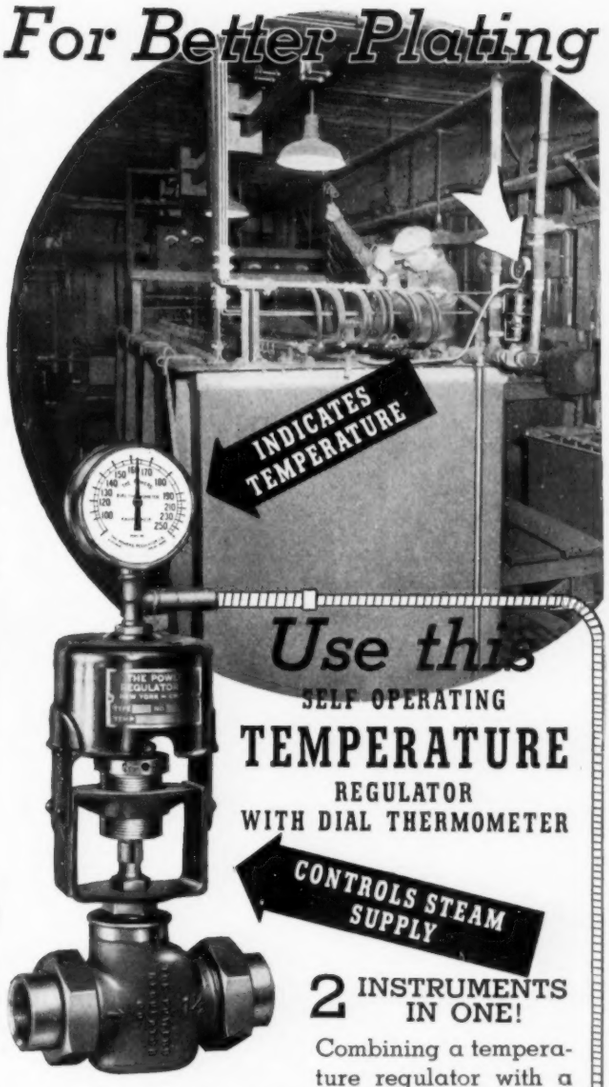
GENERAL CERAMICS COMPANY

30 Rockefeller Plaza, New York, N. Y.

BUFFALO: 306 Jackson Bldg.—CHICAGO: 208 S. La Salle St.—LOS ANGELES: 415 South Central Ave.—PORTLAND: Railway Exchange Bldg.—SAN FRANCISCO: 276 Monadnock Bldg.—SEATTLE: 1411 Fourth Ave. Bldg.—SPOKANE: 1823 South Maple St.—TACOMA: Tacoma Bldg.—MONTREAL: 1537 Matthews St.

GENERAL CERAMICS COMPANY
CHEMICAL STONEWARE

For Better Plating



Use this

SELF OPERATING

TEMPERATURE

REGULATOR
WITH DIAL THERMOMETER

2 INSTRUMENTS IN ONE!

Combining a temperature regulator with a dial indicating thermometer gives your employees a visual check on the performance of the regulator and makes it easy to adjust it for the required operating temperature. EASY TO INSTALL—Both thermometer and regulator operate from same thermal system.

Mail Coupon Below to:

THE POWERS REGULATOR COMPANY

2779 Greenview Avenue
CHICAGO, ILL.

35

Please send prices and further information on your No. 11 Regulator with dial thermometer for plating baths to:

Name_____ Title_____

Address_____

City_____ State_____

Stability—it is easy to apply, unaffected by varying oven conditions, and produces a consistently uniform finish.

Economy—rejections minimized—coverage per gallon increased over other types of finishes designed for the same purpose.

Product appeal—responses to presentation to many representative metal products manufacturers indicate acceptance of this new finish.

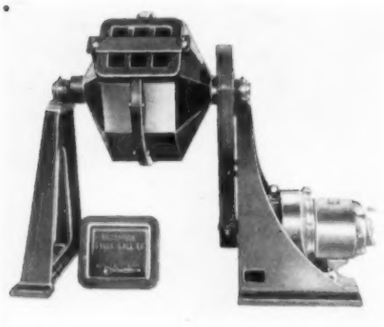
Complete information on Duotone may be secured from The Glidden Company, Cleveland, Ohio.

Triple-Action Cutting Barrel

A new smaller size cutting barrel for use in cutting-down, wet and dry grinding, tumbling, pulverizing and mixing, has recently been placed on the market by the Hartford Steel Ball Co., Box 146, Station A, Hartford, Conn.

While less than half the size of the smallest Hartford barrel previously available, this new equipment is said to embody the same design principles which produce a "triple-action" in tumbling the material . . . an "over and over," "end to end," and "folding-in" motion combined, which quickly grinds off burrs, finishes and smooths the general surface of any article in the load. The greatest use for this type of barrel is in wet grinding—usually termed sand rolling (sand and water or oil and emery).

The barrel shown in the photograph is fitted with both a solid and a strainer cover. The solid covers are equipped with automatic pressure relief valves. The barrel body castings are made of a special alloy which insures long life and rapid cutting action.



Triple action cutting barrel.

This barrel is furnished with either a built-in U. S. Syncrogear, type G.D., 2 h.p. motor as shown in the photograph or for belt drive. An automatic magnetic starting switch is included with the motor drive machine together with a remote control push-button station. The motor drives a roller chain and sprocket which is completely protected with a shield.

These cutting barrels are recommended for the finishing of parts for casters, ball bearings, screw machine products, small iron and bronze castings, hardware, roller bearings, typewriter and office machine parts, wrenches, airplane parts, locks, link chains, many varied stampings, etc.

Soft, Semi-Bright Nickel Electroplates

A new soft, semi-bright nickel alloy electroplate is now being produced commercially by a process of the Hanson-Van Winkle-Munning Company of Matawan, N. J., manufacturers of electroplating equipment and supplies. This process was developed to supply a need which has not been fully met by either the bright nickels heretofore available, or by the conventional grey nickel deposits.

Bright nickel deposits as generally known are inclined to be somewhat hard. They are widely used because of the savings which they effect by the elimination of most, and in many cases, all of the buffing on the deposited metal, although a part of this saving is lost in the additional buffing and coloring necessary on the basis metal. In those cases where it is advisable to touch up the deposited nickel, difficulty is often encountered by reason of the hardness of the deposit.

The new soft coating described below is nearly as bright as the typical bright nickels; at the same time it flows under pressure on a buff much more easily than either the standard grey nickel or bright nickel. Only the lightest "fanning off" on a loose, medium-speed buff is required to give the deposit a fine deep lustre. The light pressure on the wheel eliminates the danger of cutting through the deposit on corners and projections. The deposit is extremely ductile, and will stand mechanical forming operations without flaking or peeling, having excellent adherence, even when deposited directly on iron or steel.

Under properly controlled conditions, this deposit on buffed copper or brass may be lustrous enough to go directly into the chromium tank without buffing, but average practice calls for heavy deposits at high current densities followed by a light coloring operation before chromium plating.

The salt spray resistance of the deposit is excellent, and will take chromium plate nicely without extra treatments.

The electrolyte used is an adaptation of the Weisberg and Stoddard cobalt-nickel solution, made by the removal of the sodium salts, a reduction in the ammonium salt content of the solution, and lowering the cobalt content of the anode. The nickel anodes are of the cast carbon type, containing a small percentage of cobalt. The solution operates between 2 and 4 pH, at temperatures between 140° F. and 180° F. Brightness of deposit is increased by using higher temperatures with lower pH values. The maximum brightness is obtained by agitation, by air or mechanically. However, for heavy deposits on steel, where a slightly gray color is not objectionable, agitation is not indispensable. The throwing power of the solution is best at the higher pH levels.

Current densities as high as 75 and even 85 amperes per sq. ft. can be employed by the use of proper racks and sufficient agitation. Brighter deposits are obtained at the higher current densities.

Constant filtration is very important. The solution must be kept free of even small amounts of impurities like lead, copper, zinc or iron, although these impurities can be easily removed by plating out at low current density. Certain organics are also objectionable but they can be removed by treatment with hydrogen peroxide and filtration through activated carbon.

This solution uses no wetting agents and is consequently free from the disadvantages of susceptibility to contamination by oils and greases which are dispersed throughout the ordinary bath by the wetting agents.

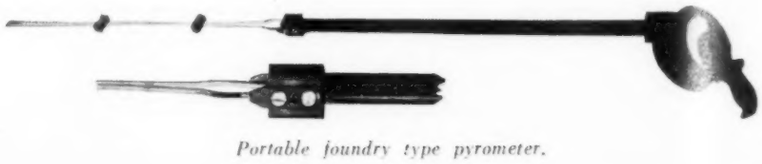
Savings are realized by the reduction in buffing labor and the buffs and compositions consumed in coloring the deposit. Many instances have also been reported in which fewer polishing operations are necessary before plating, still achieving the same lustre after nickel coloring. The cost of operating the solution is said to be considerably less than that of bright nickel.

New Portable Pyrometer

The Lewis Engineering Co., Naugatuck, Conn., has developed a new portable pyrometer (foundry type) with the following claimed features: 4½" long scale allows for excellent readability; vibration proofed mechanisms; pistol grip handle and angle set scale makes handling and reading easy; aluminum castings assure ruggedness and light weight; armored cover glass decreases possibility of breakage; cold junction carried inside of instrument case where full automatic compensations are accomplished.

The portable pyrometer illustrated is designed for measuring the temperature of molten metal in furnaces, ladles and crucibles. It was designed in conjunction with several different foundry men in their own non-ferrous metals plants. Their suggestions and demonstrations of the usage that is expected of an instrument on a production job have led to this new and unusually rugged design.

Taking the cold junction of the thermocouple inside of the instrument and automatically compensating for cold junction



Portable foundry type pyrometer.

and ambient temperature errors throughout the range of —20°F. to +120°F. is an additional feature that is particularly desirable in foundries.

The instrument is available with the following scale ranges:

88HP10	50—1000°
88HP12	50—1200°
88HP16	50—1600°
88HP20	50—2000°
88HP25	50—2500°

All standard instruments are furnished with an 18" long thermocouple. Greater lengths are available at a slight additional cost to the standard prices.

New Baking Enamel

A new baking enamel, which reproduces the colors of many metals, has been developed by Maas & Waldstein Company, makers of industrial finishes, Newark, New Jersey.

With this new enamel, which is known as "Baking Platelustre," any polished metal can be made to resemble brass, chemically treated aluminum and steel, and other colored metals, according to the manufacturer. It is very durable when baked, and will then resist the action of cleaning operations and also nickel, chromium and other plating baths so that, when applied sectionally, a wide variety of effects is made possible. Flat stock finished with this enamel can be formed after baking. Two-color finishes can be obtained by "relieving" operations.

Baking Platelustre can be applied to any kind of polished metal by spraying or roller coating. It is especially suitable for compacts, novelties, lighting fixtures, and other products where a brilliantly colored metallic finish is wanted.

Oblique Gang Type Tumbling Machine

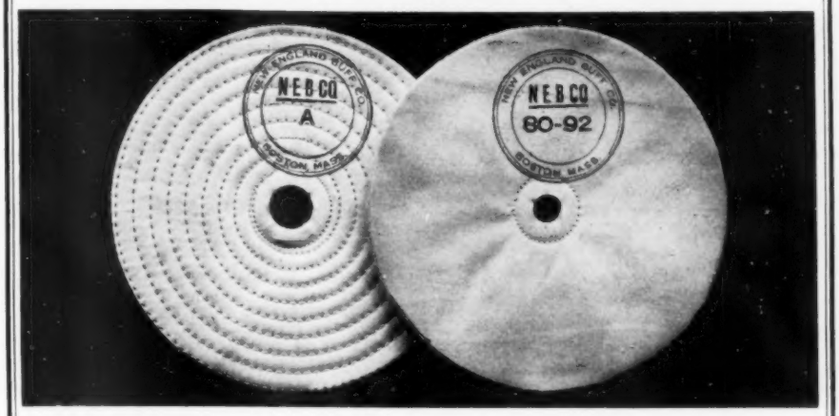
Munning & Munning, Inc., 202 Emmett St., Newark, N. J., have developed a new gang type oblique tumbling machine, herewith illustrated, which is said to be simple to operate and of wide utility.

The machine is unique in its compactness, and affords sizable scale production with bench operation. Although the apparatus shown is a four cylinder unit having different sized barrels, it can be constructed into as many drums of the same or different capacities as desired.

Noticeable among its features is the fact that the cylinders are mounted on thrust bearings, so that the weight of the load is not borne by the worm gear drive; the cylinders are light and detachable, and are lifted off their spindles for convenience in filling and emptying. The angle of rotation is such that the cylinders project sufficiently forward so that open gas flames may be directed externally at the lower angle of the drums when revolving, if special operations require heated treatments.

The table arrangement affords convenient handling of the work and enables the machine to be locked against a wall to conserve floor space.

NEW ENGLAND QUALITY BUFFS



ENDURANCE

New England Buffs assure long life and efficient performance on any type of surface. They are made from the highest quality sheeting obtainable—Sheeting made specifically for the Buffing Trade.

THRIFTY

New England Buffs hold the composition well—will not burn at high speeds or under pressure.

STABILITY

Use New England Buffs for cutting down and finishing aluminum, brass, copper and stainless steel.

We can furnish the proper buffs for your needs. Re-orders can and will be duplicated according to the necessary specifications. Ask for samples or place a trial order.

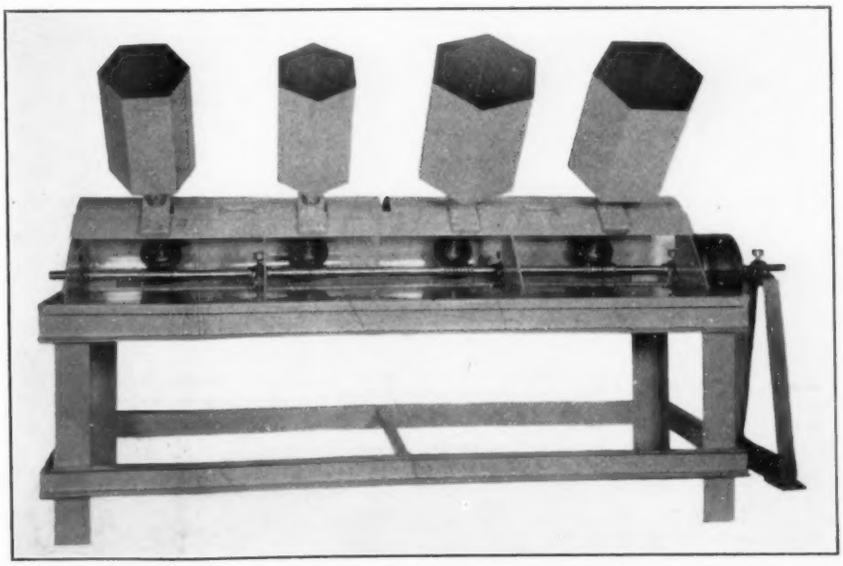
NEW ENGLAND BUFF CO. NEBCO PRODUCTS SINCE 1890 BOSTON, MASS.

NEW ENGLAND BUFF COMPANY

493 C Street, Boston, Mass.

Established in 1890

For almost fifty years we have been manufacturing Cotton Buffs of every description.



Gang type oblique tumbling machine.

CHROMIC ACID

Recognized as the world's largest manufacturer of chromium chemicals, Mutual brings to the plating industry a basic source of chromic acid.

Our facilities cover every step in its production, from the mining of the chrome ore on a remote island in the Pacific to the wide distribution of the finished product through warehouse stocks in the principal consuming centers.

MUTUAL CHEMICAL CO. OF AMERICA — MUTUAL — NEW YORK, N.Y.

CHROMIC ACID
OXALIC ACID
BICHROMATE OF SODA
BICHROMATE OF POTASH

Mines in New Caledonia
Plants at Baltimore and Jersey City
Warehouse stocks carried in all principal cities.

MUTUAL CHEMICAL CO. OF AMERICA
270 Madison Avenue, New York City

The fabricated steel construction of this unit permits of modification in length, number of cylinders, and type of drive.

The apparatus pictured with pulley for belt, is the simplest model; but the machine is furnished with either direct connected motor gear reducer or with V-belt drive as preferred. It is also constructed in either single or multiple barrel units with independent tilting mechanisms, so each cylinder may be loaded or unloaded individually without interference to the operation of the other drums.

Cleaner for Chromium Plating

MacDermid, Inc., Waterbury, Conn., have developed a cleaner called Resistex which has been designed to function as a cleaning material prior to chrome plating, especially after bright nickel or buffed nickel operations. In some cases where highly polished brass or nickel silver parts are processed for chrome direct, the cleaner, it is said, may be safely employed.

In addition to exhibiting detergent properties, it is compounded so as to absorb maximum amounts of chrome solution which adheres to racks, without rapid deterioration or loss of cleaning efficiency. Laboratory experiments as well as practical factory observations, indicate it is reported, that Resistex will withstand chrome solution attack from 2 to 4 times longer than most other cleaning materials.

This cleaning material can be used with or without current. For removing various types of buffing compounds used for coloring nickel, cathodic cleaning only is recommended. Current densities of from 15 to 30 amps. per sq. ft. may safely be employed, and is claimed not to discolor or cause oxides to form and promotes smooth lustrous chrome deposits.

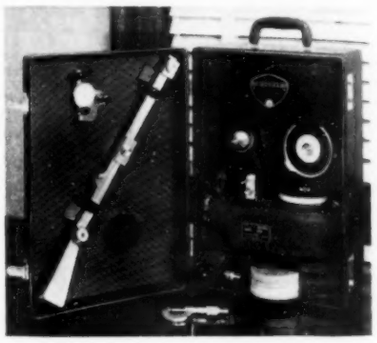
When this cleaning compound is used solely for bright nickel cleaning a concentration of 4 oz. per gallon is sufficient. When cleaning touched-up bright nickel or regular nickel buffed parts, 6 oz. per gallon is recommended. Temperatures 190°-200° F. in each case. For the occasional plant that is processing brass or nickel silver for chrome direct, a 4-oz. solution is sufficient.

For further details, write MacDermid, Inc., Waterbury, Conn.

Wear Tester for Organic Finishes

Taber Instrument Co., North Tonawanda, N. Y., have developed an instrument called, Taber Abraser, Model J portable, which has been designed for measuring the amount of wear and the abuse that various types of surfaces will withstand.

Its range of application is said to include practically all painted and lacquered surface finishes, rubber, Durez, Bakelite, Polystyrene and similar compounds, vitreous enamels, gold, silver, nickel, chromium electroplate. The Abraser conforms to the best standard accelerated testing practice as the calibrated wheels alternately cross-rub back and forth over a circular path approx. 2 sq. in. in area, producing a wear action very similar to that occurring under actual service conditions. The wear is continuous and at a practically constant rate due to careful design and co-ordination of the various factors involved in the test. A powerful dual blower provides cool streams of air for both motor and rotating holder, effectively preventing heating of the test specimen.



Taber Abraser wear testing outfit.

Testing a chromium plated specimen.

The end-point of the test for coatings is when penetration of the film is first observed, or in the case of solid materials,

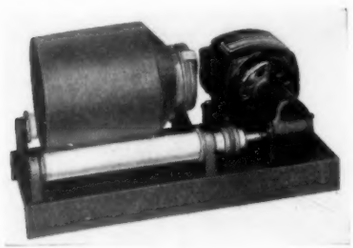
the test is continued to a depth of .001" to .005". Accurate measurement of the wear depth to the nearest ten-thousandth of an inch is taken with suitable micrometers, and the wear per mil (.001") calculated.

A shear test attachment gives a numerical rating for toughness of organic substances such as paint and lacquer coatings, molded plastics, etc. This test reflects the ability of the surface finish to resist scrapes, digs, cuts and similar damage.

New Jar Mill

United States Stoneware Co., 60 E. 42nd St., New York City, has developed jar mills which are claimed to be ideally suited for the grinding and pulverizing of pigments, minerals, inks, colors, chemicals, etc.

The Loxeal jars are stated to be sturdy and of rugged construction, and in sizes of 1, 1½ and 2 gallons. The Loxeal jars are made of chemical stoneware, tapered at one end to a 4¼" opening. The lids are gasketed and held in place by means of a patented clamp.



Jar mill.

The jars need not be clamped into frames or housings, but are merely set upon the revolving rollers which consist of rubber-covered steel and are mounted in brass-bushed bearings. The motors are of the continuous-duty, geared-head type, the one and two-jar machines being supplied with ¼ H.P., 110 volts, single-phase, 60 cycle motors. A slight extra charge is made for motors of different characteristics. The revolving speed (1½ gal. jar) is about 50 R.P.M.

Further information and literature can be secured by writing to the United States Stoneware Company.

FULL TO THE BRIM

WITH SATISFACTION

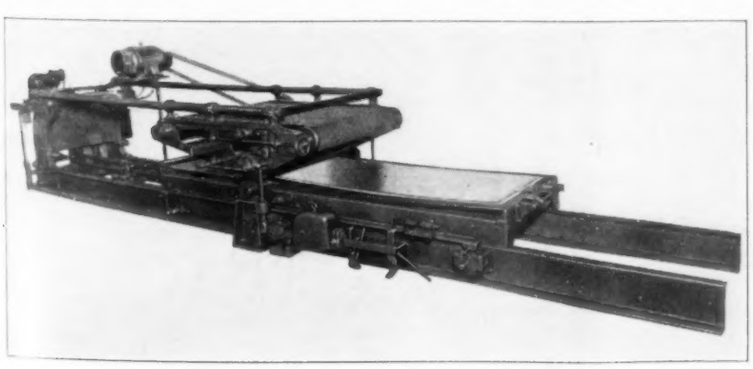
Empty when you receive them . . . yet . . . brimful with high quality material and workmanship values . . . rightly priced . . . to serve your want and need for economy and utility . . . in tank procurements.

PROMPT SHIPMENT—ON SINGLE TANK UNITS OR COMPLETE CYCLES WITH ALL ACCESSORIES—24 HOURS SHIPPING SERVICE ON ARMCO IRON TANKS, LEAD COILS AND LEAD LINED TANKS

STORTS WELDING COMPANY
42 STONE STREET — MERIDEN, CONNECTICUT — Telephone 1991
MANUFACTURERS OF WELDED FABRICATIONS TO SPECIFICATION

Polishing Machine for Stainless Steel

The Excelsior Tool & Machine Co., Ridge Ave., 30 to 32 St., E. St. Louis, Ill., has developed a stainless steel sheet polishing machine, which can be installed by stainless steel equipment manufacturers to polish their sheets to any required finish for their job in process, thereby, it is said, reducing their finished stock requirements, avoiding considerable delay and stock inventory expense.



Polishing machine for stainless steel.

The manufacturers claim that stainless steel sheets can be polished by the Excelsior method at a saving up to 75% under the mill charge for No. 4 finish sheets by operator with 2 days' operating instructions, and that 4 to 20 sheets any gauge up to 48" wide by 12' long can be polished in one hour by 2 men, depending upon the width and finish unless the sheets are too heavy to handle. The grinding belts are removed and replaced within 5 minutes and require no further adjustment after they are centrally located on the drums.

The machine is recorded to be fool-proof, all the objectionable difficulties with machines used for this purpose in the past are eliminated. All adjustments are mechanically controlled and adjusted in one location. The positive clamping attachment for the

Attend the Educational Sessions of the

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Cathanodic
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CLEANING PROCESS

for the answer to your METAL CLEANING problems.

Let us solve your cleaning problems. Write for full particulars on Cathanodic Cleaning Process and Clepo Cleaning Compounds.

FREDERICK GUMM CHEMICAL CO.
INCORPORATED
538 Forest St., Kearny, N. J.
Western distributor
BELKE MFG. COMPANY, 947 N. Cicero Ave. Chicago, Ill.

CLEPO CLEANING COMPOUNDS

sheets and the accurate adjustable travel of the carriage prevent any possible damage to the polishing belts or the rubber-covered contact pressure drum.

The pressure on the grinding belts, which is from 200 to 600 pounds, is applied by the gravity pressure principle regulated by removable hand weights, assuring positive regulated pressure contact over the entire width and length of the sheets to be polished.

The drums, diametrically balanced, revolve in oversize dust-proof ball bearings and are mounted in rigid cast steel housings. There are no metallic connections between the polishing head and the carriage thereby eliminating vibrations on the sheets to be polished. A 25 H.P. motor operates the grinding belts at 3500 lineal feet per minute. A separate 2 H.P. geared motor is used to reciprocate the table at 60 ft. per minute. Commercial paper grinding belts up to 50" wide by 16' endless of any width to suit the width of sheets to be polished are used, No. 120 and 150 grit belts will polish No. 2-B mill sheets to No. 4 finish.

The manufacturers state that the machine has been in daily operation for over a year in a large rolling mill, and the late improved machine is in operation in a well established hotel equipment manufacturing company.

Further information and operating tests can be obtained by writing to above company.

Manufacturers' Literature

Acid-Proof Cement. Penchlor, a cement which is reported to resist steam, hot or cold water, hot or cold salt solutions of all strengths, and hot or cold acids of all strengths, without extensive treatment. Booklet No. 3. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.

Agitators. Air Motored Mixer. A folder cataloguing the complete line of air motored agitators, both direct and gear driven, published by Pneumix Division of Eclipse Air Brush Co., Inc., 398 Park Ave., Newark, N. J. Safety features and variable speeds are set forth together with illustrations of actual installations of these mixers.

Air Cleaning and Dust Collecting Equipment. Catalog giving information about air cleaning and dust collecting equipment, and featuring Centri-Merge wet system of dust collecting. It also deals with dust arresting in both centralized and localized systems, spray booths, air washers, parts washers, cyclones, and other special equipment. Illustrated with reproductions of equipment and installations, along with diagrams. Schmieg Sheet Metal Works, Piquette & Brush Sts., Detroit, Mich.

Analytical Set. A folder describing a new Kocour analytical set for analyzing silver plating solutions. This set enables the determination of metal content, free cyanide and carbonate easily and with direct readings. For information and prices write to Kocour Co., 4724 S. Christiana Ave., Chicago, Ill.

Burnishing Materials. A folder on Beaverbright Burnishing Soaps especially applicable for barrel burnishing fine work, such as hotel silverware and other fine plated products. H. Leroy Beaver, Lansdale, Pa.

Caustic Soda. A booklet containing the following chapters: Physical and Chemical Properties; Strength-Density Relations of Water Solutions, Freezing Points of Water Solutions, Viscosity of Water Solutions, Specific Heat of Water Solutions, Heat of Solution, Conversion Tables, etc. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.

Control Instrument. Improved Taber V-5 Stiffness Gauge. Bulletin No. 3802 Rev. I. This gauge, it is said, is designed for the accurate measurement of the stiffness quality of paper, light metallic sheet and wire, meeting the exacting requirements of the modern research laboratory. Taber Instrument Co., North Tonawanda, N. Y.

Corrosion Resistant Coating. A folder describing the story of *Impervium*, a new synthetic product for coating plating tanks, racks and other equipment to resist various acids and corrosive agents used in plating. Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Mich.

Equipment for Head and Eye Protection. 24th catalog edition lists complete line of goggles, respirators, spectacles, masks, welding helmets and other safety devices. Besides regular product listings, will be found general information on how non-shattering lenses are made; what a worker should wear when exposed to ultra-violet and infra-red light rays, etc. Chicago Eye Shield Co., 2300 Warren Bldg., Chicago, Ill.

Finish. Spekaluminite. A folder on an aluminum finish which is said to be easy to apply—dip or spray, then bake. Special Chemicals Corp., 30 Irving Place, N. Y. City.

Grinding Machines. A folder on roll grinding machines, 36"-44"-50"-60", designed to grind and regrind the necks and bodies of straight, concave or convex hot and cold plate mill rolls, sheet and tin mill rolls. Cincinnati Grinders, Inc., Cincinnati, Ohio.

House Magazine. Oakite News Service. March-April 1939. A highlight in this magazine is an article on "How Tin Coatings Are Applied," a condensed factual review of electro-tinning and hot-tinning. Cleaning of the base metals is also discussed. Oakite Products, Inc., 22 Thames St., New York.

Metallography. Enthone Metallographic Cleaner. A folder claiming the following advantages for this cleaner: scratch-free polishing of specimens for microscopic examination; prevents glazing of wheels and specimens; removes solid particles from polishing cloths, specimens and operators' hands; all purpose laboratory cleaner; harmless to hands. Enthone Co., New Haven, Conn.

Metal Tubing. Seamless Flexible Metal Tubing. The catalog contains discussions on the proper use of the product for conveying steam, liquids, gases; controlling vibration, connecting misaligned and moving parts, and the part that Seamless plays in product design. There are also engineering data and specifications with simple installation rules; illustrated. American Metal Hose Branch, American Brass Co., Waterbury, Conn.

Nickel Alloys. Bulletin T-13 on Nickel and Nickel-Base Alloys—Their Use in the Design of Corrosion-Resistant Machinery and Equipment, carries many changes from the preceding one. The text has been enlarged, and for some sections, rewritten; the tables and curves revised to include the latest available information. International Nickel Co., 67 Wall St., N. Y. City.

Method of Lubrication. Bulletin 150 describes a method of lubricating saturated and superheated steam engines to produce oil-free exhausts. Depending on whether oil-free exhausts are desired, the lubricant consists of colloidal graphite suspended either in water or in oils. In the latter case, the use of "dag" colloidal graphite has resulted, it is reported, in effecting material savings over the cost of plain lubricants by reducing oil feed, minimizing wear and assuring protection under extreme running conditions. Acheson Colloids Corp., 2150 Washington Ave., Port Huron, Mich.

Polishing and Buffing—"The Lea Method of Finishing." A booklet published by Lea Manufacturing Co., Waterbury, Conn., on methods of polishing and buffing of metals, plastics and non-metals; describes methods of producing satin finishes and sequences of operation of polishing and buffing, starting with the original castings or wrought metal.

How About Your Polishing and Buffing?

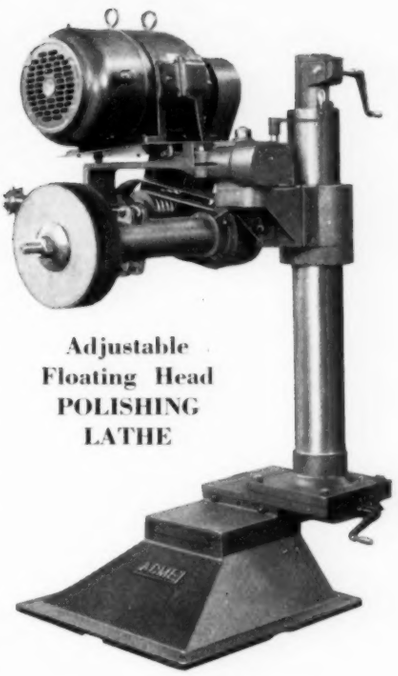
Is It Too Slow?

Too Costly?

Switch Over to Acme!

Ten chances to one, you can solve your problem with an Acme Automatic—increasing production, reducing costs, and turning out a more uniformly finished product.

Take, for example, the machine shown at the right. With a head that can be adjusted vertically, horizontally or angleways for cross-cutting, it can be used in conjunction with straight line, rotaries, ends of rolling mills and other types of holding equipment.

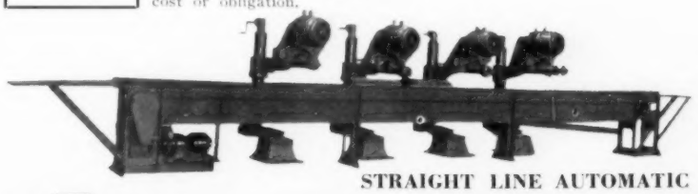


Adjustable Floating Head POLISHING LATHE

Send Sample for **FREE** Production Estimate

What's Your Problem?

Acme Machines are made in many different types — each one designed to handle a particular buffing or polishing operation more speedily and more economically. Tell us what's bothering you and we'll supply the answer—without cost or obligation.



Polishes or buffs grilles, mouldings, strips, etc.

STRAIGHT LINE AUTOMATIC

ACME Manufacturing Co.

1642 HOWARD ST. • DETROIT, MICH.

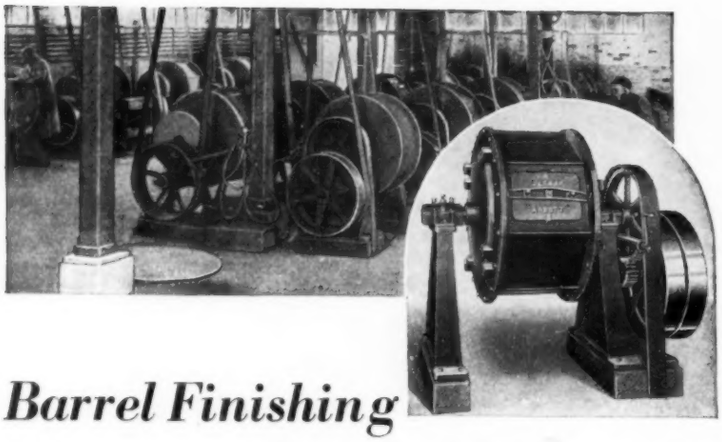
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

Process. Thermotrol. A folder on a process to control the melting and casting of gold for jewelry. Features claimed are: porosity minimized, added protection against pitting, gold is cast at its critical temperature, no guess-work, maximum density, simple to operate. Sigmund Cohn, 44 Gold St., N. Y. City.

Presses, Shears and Machines for Sheet Metal and Plate Work. A broadside giving a pictorial resume of the complete line of latest type Niagara presses and shears. Niagara Machine & Tool Works, 637 Northland Ave., Buffalo, N. Y.

Roof Coating. A folder on "Longlife", reported to be a pure mineral asphalt, unadulterated with solvents, chemicals, sludge or foreign matter, put into usable form. This material is applied cold as a roofing, for waterproofing, for low cost factory caulking and for many other purposes. Flexrock Co., 23rd & Manning Sts., Philadelphia, Pa.

Stock List. A new booklet listing stocks of various metal products, also giving specifications. Scully Steel Products Co., 1319 Wabansia Ave., Chicago, Ill.



Barrel Finishing

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FAST production, uniform results, negligible unit cost. Those advantages are reported by manufacturers finishing stampings, forgings, castings and other small parts in Abbott Burnishing Barrels.

Pecks of work can be brightly finished at a load. Before plating, ball burnishing prepares an ideal base in an hour or two by rolling down the tiny highlights and closing the pores of the metal. After plating, a short run brings up the final color.

High and narrow Abbott Barrels confine the load within a vertical area. Pressure of the burnishing materials is directed on the work—none is wasted. This rolling, rubbing pressure is the backbone of successful burnishing.

Put it up to our Experimental Department to demonstrate on some of your unfinished parts. This free service may be the first step toward lower finishing costs. Worth a try, isn't it?

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Order for prompt shipment from our complete stocks

Retarder. Lacquer Retarder. A folder on a lacquer retarder which claims to stop blushing of lacquers in damp weather, and to insure maintenance of production schedules especially for the lacquering of those articles which are prone to blushing. Enthone Co., New Haven, Conn.

Stripper. Baked Enamel Stripper. A folder discussing this stripper, which is said to be harmless to aluminum, zinc, lead, and magnesium alloys. Dilutes with water and is simple to operate. Enthone Co., New Haven, Conn.

Tanks for Pressure Blast Cleaning. Bulletin on Sly PB tanks. It describes the advantages of this unit for cleaning the surfaces of forgings, castings, structural steel work, bridges, tanks and buildings from adhering scale, molding sand, dirt and old paint as well as preparing surfaces for metal coating, mat finishes, etching, etc. Tables, specifications, etc. are included. W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland, Ohio.

Tin and Its Uses. A quarterly review issued by the International Tin Research & Development Council, 149 Broadway, N. Y. April 1939. No. 1 contains information on the Council's new headquarters, research on tin alloys, the tinplate and canning industries, etc.

Electro-Tinning. Publication No. 92. Notes on the advantages and limitations of the various processes and on methods of preparing, controlling and analyzing the solutions used. International Tin Research & Development Council, 149 Broadway, N. Y.

New Books

Statistical Year Book 1939. A compilation by the Statistical Office of the International Tin Research & Development Council. The object has been to collect all the available statistical information relating to the quantities of tin produced at mine or smelter and consumed in the various countries, and also to show as far as possible how much tin is used in the different industries. International Tin Research & Development Council, 149 Broadway, N. Y. Price 8s 0d.

Metal Statistics 1939. Thirty-second annual edition. Published by American Metal Market, New York City. Size 6" x 4"; 632 pages. Price $2.00.

The thirty-second annual edition of Metal Statistics contains the same general assortment of statistical information on ferrous and non-ferrous metals and miscellaneous economic subjects supplied in earlier numbers, and again embraces numerous additions and alterations calculated to still further enhance its value as a reference guide to members of the industry.

Thus, presented for the first time, in the iron and steel section are statistics on molybdenum, ferrosilicon and magnesite, as well as new tables showing rolled steel "produced for sale," tin plate production by quarters, and output of drawn and barbed wire, etc.

In the non-ferrous metals section, the principal change of note is a new series of monthly tables on domestic and foreign crude and refined copper statistics, the compilation of which have been made possible by the release of figures by Copper Institute, Inc., going back to the middle of the year 1933. In the record of daily prices in 1938, dealers' buying prices for heavy copper scrap have been displaced by copper refiners' bids for No. 1 wire scrap. Other new tables include monthly average prices on two grades of remelted aluminum and a record of price changes together with dates on prime western zinc, East St. Louis.

As in previous editions, prices given in this volume are based mainly on the daily quotations appearing in American Metal Market, and represent wholesale selling prices.

Virtually all the iron and steel production statistics are gathered by the American Iron and Steel Institute, while the production statistics on metals are, with a few exceptions, based mainly on figures furnished by the United States Bureau of Mines, the American Bureau of Metal Statistics, Copper Institute, Inc., and the American Zinc Institute.

The Microscope in Elementary Cast Iron Metallurgy, by Roy M. Allen, brown cloth waterproof binding, 160 pages, 6 x 9 inches, 73 illustrations, published by the American Foundrymen's Association, 222 West Adams St., Chicago, Ill. Price $3.00.

This book is an enlargement of the mate-

rial presented at a series of lectures at the 1939 Convention of the American Foundrymen's Association in Cincinnati, Ohio. The book is written in simple language that can be understood easily by both the novice and the expert. The author has made a determined attempt to show the practical man that there is nothing particularly difficult about the fundamentals of metallurgy, the microscope, its use, nor the interpretation of photomicrographs if such fundamentals are understood.

The first section of the book deals with the value of the microscope to the cast iron foundryman and continued with the fundamentals of physical cast iron metallurgy. In these chapters the author uses simple analogies with which everyone is familiar to drive his points home. He then embarks on an explanation of the behavior of sulphur and phosphorus in cast iron, how they can be identified in the microstructure, and their effects on the properties of the iron. The fourth chapter deals with what the author terms special cast irons, such as white, chilled, malleable, and alloy cast irons, explaining variations in properties by use of photomicrographs.

In the next section, the author explains the value and use of equilibrium diagrams. He begins with an explanation of simple binary diagrams and then proceeds to show how the same principles can be applied to the more complicated diagrams, particularly the iron-iron carbide diagram. Of special interest should be the equilibrium diagram the author proposes to explain the behavior of cast iron.

In the final chapter, the microscope and the technique of its use are discussed. The various parts of the microscope are explained and the function each performs. In addition, technique in focussing, taking the photomicrograph, photographic processes, photographic papers, etching reagents and sample preparation are discussed. Various types of equipment for grinding, polishing and photographing metal samples are shown.

It can be said that the book not only explains procedures for securing, grinding, polishing, etching, observing and photographing of the sample, but the interpretation of both what is seen in the microscope and in photomicrographs.

Introduction to the Study of Heat Treatment of Metallurgical Products. By Albert Portevin. Published by The Penton Publishing Co. 246 pages. Price $5.00.

To acquire the fundamental knowledge and the essential principles concerning the thermal treatments of steel in a simple manner involves an elementary course of teaching. With this in mind, Albert Portevin, distinguished French physical metallurgist, has made an attempt in his book to appeal mainly to the intuitive notions and to the experimental determinations and facts resulting from observation.

He has emphasized his plan in a simple manner by various supplementary chapters wherein elementary experiments are cited and laboratory study apparatus described. These chapters constitute the description of manipulations which clarify or supplement the preceding chapter.

Subjects treated by the author include transformation points of steel, preliminary treatment of steel, quenching, hardened steels, hardening capacity of steel, tempering, classification of industrial steels, annealing, malleabilization of cast irons, heat treatment of light aluminum alloys, etc.

The reader will not encounter recipes, formulae or numerical results. The book is neither an encyclopedia nor a book of formulae. The aim of the author has been to include ideas and directions to interpret and understand the phenomena and solve the difficulties which actually occur in the heat treatment of various commodities.

Research engineers, metallurgical students and steel plant metallurgists, as well as others engaged in metallurgical investigation and the heat treatment of ferrous and non-ferrous metals, will find this work of inestimable value.

Alloy Cast Irons, a Project of the Gray Iron Division of the American Foundrymen's Association, semi-flexible imitation leather, 270 pages, 6 x 9 inches, 111 charts and illustrations, 73 tables, published by the American Foundrymen's Association, 222 W. Adams St., Chicago, Ill. Price $3.00.

"Alloy Cast Irons" covers the effect of 18 different elements on the various properties of gray, white and chilled cast irons. Information is given on the effect of aluminum, bismuth, carbon, chromium, cobalt, copper, magnesium, manganese, molybdenum, nickel, phosphorus, silicon, sodium, sulphur, titanium, tungsten, vanadium and zirconium on such properties as tensile, transverse, shear, torsional and impact strengths, hardness,

—DURIRON and DURICHLOR

CENTRIFUGAL PUMPS
Standard
Self-Priming

VALVES
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Lubricated
Quick-Releasing

HEAT EXCHANGERS
Heating and
Cooling Units

PIPE and FITTINGS

The high silicon irons, Duriron and Durichlor, handle plating solutions regardless of character without deterioration or contamination.

The largest producers in the automotive and other fields are using Duriron and Durichlor equipment to reduce costs and increase production.

Bulletin No. 1601—Duriron Heat Exchangers—contains detailed information and will be sent on request.

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Save Time and Money

ON WET
OR DRY
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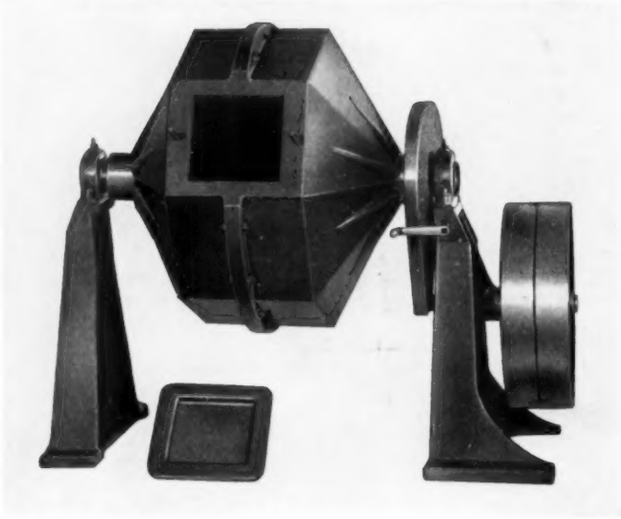
with
the



"TRIPLE ACTION" HARTFORD

3,000 pieces finished in a "HARTFORD" in the same time as 90 pieces by hand! Here is a typical example of the time savings resulting from the use of HARTFORD Triple Action Tumbling Barrels over ordinary methods for grinding burrs from metal parts and finishing surfaces.

WHAT "TRIPLE ACTION" MEANS

The "HARTFORD" method is different and this difference means finer quality results, produced at lower cost. In the "Hartford" a TRIPLE ACTION of turning parts "over and over, end to end and folding in" is obtained. The result is a finer, smoother finish in far less time. This action insures the uniform cutting of each piece.

HARTFORD BARRELS—in 10 cu. ft. and 4 cu. ft. capacities—and for either belt or motor drive—will handle wet or dry grinding (using sand and water or oil and an abrasive) as well as pulverizing and mixing. Regardless of how used, the "Hartford" TRIPLE ACTION feature insures quick, quality work at lowest cost. Our engineers are available to assist you in modernizing your tumbling barrel operations. Write for Illustrated Bulletin, giving full details.

THE HARTFORD STEEL BALL CO.
HARTFORD CONNECTICUT

deflection, machinability, wear resistance, heat resistance, corrosion resistance, mass and section, electrical properties, thermal properties, chill, etc.

"Alloy Cast Irons" also discusses the forms in which alloying elements are available commercially and the different types that are added to various melting units. General foundry practice used in the manufacture of alloy cast irons, covering such subjects as melting, molding sands, heat treatment, shakeout practice cleaning and finishing, etc., also is covered.

Of special interest should be the chapter devoted to composition, mechanical properties, uses and service data on many types of alloy cast irons in commercial applications. For those desiring still more complete information on the subjects covered, a 25 page bibliography is available. The 14 page cross index at the rear of the book makes the desired information easily found.

Tool Making. By C. B. Cole. Published by American Technical Society, Chicago. 413 pages. Price $3.50.

This book has been prepared so that the beginning toolmaker is led from the simple facts about his personal tools and the equipment which the shop provides, to the processes of the toolmaker's craft. This is done through the actual presentation of typical jobs. These jobs are presented as finished working drawings, and the tools which they represent may be made from these drawings. The information which the drawings supply will contribute greatly to the training of any toolmaker. The section on production tools is especially valuable for the toolmaker with some experience.

The author has had many years of practical experience in the design and making of tools. Mr. Cole is president of the Tool Equipment Sales Company of Chicago, and member of various technical societies.

The price of "Cellulose Lacquers, Finishes and Cements," by Arthur Jones, published by J. B. Lippincott Co., Philadelphia, which was reported as $6.30, in the March issue of METAL INDUSTRY, is $10.00.

Letters From Our Readers

Unfair Anode Sales Practice

May 15, 1939.

Editor of METAL INDUSTRY,

Dear Sir:

The plating industry is offered so-called New Anodes by a number of people who are calling upon them and their proposition seems a very attractive one. Their method is as follows:

They will come into a plater and offer him a very high price for his scrap anodes and in return will give him so-called good anodes under the established price of reputable distributors. They will also try to make a trade rather than pay for the scrap anodes.

In other words, they will give him so many pounds of new anodes for their accumulation of scrap. Their idea is to get rolled anode scrap preferably. If they can't, they will take the cast anode scrap, realizing that they get less for cast anodes than they do for rolled anodes.

The anodes which they sell them are made from any kind of scrap nickel and are cast and finished to have the surface appearance of a sound good grade of anode, but in reality the nickel content is rarely above 90%.

It would be much better for the plater to sell his scrap to reputable concerns and buy his new anodes from known manufacturers.

Name withheld.

On Plating Research

Dr. Walter R. Meyer, Editor:

Up to the present time and within the past ten years, The American Electroplaters' Society, in co-operation with its associates the American Society for Testing Materials, the National Bureau of Standards, and manufacturers vitally interested in the actual protective value of electroplated coatings, have spent the sum of $60,000, to present unbiased and valuable information to all who may be interested in improving the electroplating industry, and offering the public real protection against corrosion of electroplated coatings.

Yet to say the least, there is only one industry that has availed itself of this information and utilized it for the benefit of itself and the general public; namely, the automobile industry. The consequence is that when we buy a car today, we are assured of quality, beauty and utility for years to come for all electroplated parts regardless where the car is put into service, in any of the various atmospheres throughout the world.

This is true whether one buys a cheap

car or the most expensive, as they are all subjected to the same rigid inspection before final approval by the manufacturers.

The question comes to my mind—Why have not other industries followed this trend? Perhaps there are several reasons—to name a few: Lack of interest on the part of the manufacturers themselves; contentment of their sales organizations; lack of understanding by the plater himself of what constitutes a durable deposit; lack of advertising by the A.E.S. itself on this valuable work.

Suppose for one moment that any one manufacturer has used the money, the brains and the facilities that have been used by the A.E.S. for its Research Program, and obtained the results that are now available to all who are interested, he would set himself a sales campaign that would be a sales campaign. He would use every means at his disposal to tell the world about his products, and too, he would be assured of financial backing by his banker for his undertaking as it would be a definite advancement of his product, because he would tell the public to buy his product, for the reason he would assure the buyers no matter what use to which it would be put, there would be no corrosion or breakdown of the plated parts. In addition, his methods of application and the amount of deposit would be approved by all the leading authorities throughout the world.

The A.E.S. itself is unable to undertake any such sales campaign being content to keep within its constitution, which is for the advancement of the art of electroplating, and using what money it is able to collect for the continuation of research, which must go on for the benefit of all.

But we do expect the co-operation and assistance from all who are interested in electroplated coatings, not only financially, but morally, with advice, suggestions and the adoption of the findings of the A.E.S. Research Associates, and the return for this co-operation would be increased sales, due to the fact he could and would be able to assure his buyers that they have a durable deposit. It would open markets that have, up to this time, been skeptical of plated coatings due to their resistance to climatic and other conditions—markets that have been killed by inferior deposits.

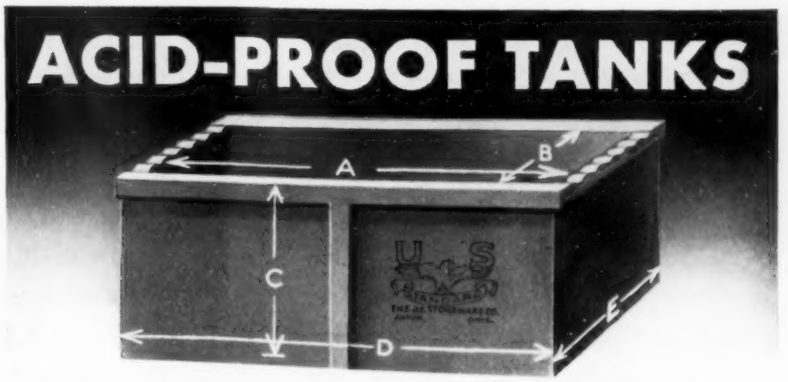
The cost of producing a durable deposit is very small in consideration of the value received, the preparatory methods for both inferior and durable deposits are identical, the actual increase in cost being, for the amount of metal deposited plus the current needed for this purpose.

The buying public today is fast becoming quality conscious and so the future of the electroplating industry and the protection of investments now made in plating departments, is in the acceptance of the findings of the A.E.S. Research Associates as may be fitted to each and any particular product.

The general acceptance of these findings and the co-operation of all parties most concerned, will assure the plating industry its rightful place in industry by the correct application of what it stands for—utility, protection and beauty.

B. W. Sage, A.E.S. Research Committee.

ACID-PROOF TANKS



Gal.	Length in Inches	Width in Inches	Depth in Inches	List Price
4	12	9	9	$14.00
10	16	12	12	23.00
16	20	16	12	32.40
26	24	16	16	42.00
38	28	20	16	65.00
41	24	20	20	66.00
44	32	20	16	78.00
66	32	24	20	96.00
69	40	20	20	104.00
104	36	28	24	140.00
119	48	24	24	152.00
149	60	24	24	206.00
210	48	32	32	248.00
320	72	32	32	360.00

Special sizes made to order. List prices subject to discount.

Made of "DENSTONE"—an Acid-Proof Chemical Stoneware, dense-bodied and non-porous, and made from De-Aired (Vacuumized) clays.

All tanks are unqualifiedly recommended for electroplating, galvanizing and pickling work. The dense, granite-like body is acid and corrosion-proof all the way through.

Write for information about our Acid-Proof Linings for:

- ACID PICKLING AND CLEANING TANKS
- BRIGHT NICKEL PLATING TANKS
- CHROMIUM PLATING TANKS
- COPPER AND NICKEL PLATING TANKS
- STAINLESS-STEEL PICKLING TANKS

THE U. S. STONEWARE CO.
WORKS (SINCE 1865): AKRON OHIO

Associations and Societies

American Electroplaters' Society

Anderson Branch

At the April 20th meeting, the following officers were elected:

President, *Dr. M. M. Beckwith*
Vice President, *E. L. McKinney*
Secretary-Treasurer, *Otto McCallister*
Board of Managers: *L. R. Hinsch, G. M. Cole* and *C. Wilson.*

Delegates to the National Convention: *R. M. Wagner, Wm. Castell* and *G. M. Cole*: alternates, *L. R. Hinsch, G. W. Onksen* and *J. W. Minton.*

Dayton Branch

At the May 5th meeting, the following officers were elected:

President, *C. C. Conley*
Vice President, *Leon Haas*
Secretary-Treasurer, *Corliss W. Powell*
Librarian, *H. C. Luechauer*
Board of Managers: Messrs. *Harter, Foltz* and *Smith.*

Delegates: Messrs. *Cochran, Conley* and *Fraine*; alternates, Messrs. *Smith, Haas* and *Vandevander.*

Detroit Branch

At the May 5th meeting, the following officers were elected:

President, *J. W. Higgins*, Packard Motor Co., re-elected.

Vice President, *Walter Pinner*, General Spring & Bumper Co.

Secretary-Treasurer, *Wright Wilson*, Chrysler Corp., Eng. Dept.

Librarian, *Dr. Richard Saltonstall*, The Udylite Corp.

GET DOWN TO BARE METAL IN ONE QUICK, *Chemically Clean* SWEEP!

Effective, economical cleaning before vitreous enamelling demands quick, complete removal of lubricants used in stamping and drawing operations. The surface of the metal must be chemically clean, no matter how hard to remove the lubricants may be.

Magnus Cleaners for Vitreous Enamelling

have been developed to take care not only of the comparatively easy to remove soluble oil or soap compounds, but the very difficult slushing oils and greases and mineral lubricants. They work fast and work completely without a trace of "smut" or "film".

If you want speedier production, assured quality and fewer rejects due to pin-holes, make Magnus Cleaners your method of getting down to chemically clean bare metal in the quickest possible time.

CALL IN A MAGNUS MAN

Let him go over your operations with you and help you select the Magnus Cleaner best adapted to your particular problems. Then make use of the liberal Magnus trial offer to test out the cleaner to your own satisfaction.

MAGNUS CHEMICAL COMPANY

Manufacturers of Cleaning Materials, Industrial Soaps, Metallic Soaps, Sulfonated Oils, Emulsifying Agents and Metal Working Lubricants.

11 South Avenue Garwood, N. J.

MAGNUS CLEANERS

Board of Managers, *Wm. McCord, Chas. Beaubien, Herbert Kennedy.*

Delegates to the convention at Asbury Park, *Wm. M. Phillips*, President, A.E.S.; *A. B. Wilson*, past president; *Carl Heussner*, Chrysler Corp.

Herbert J. Hawkins, honorary member of Detroit Branch, officiated as installation officer.

Hartford Branch

The following officers were elected for the year 1939-1940.

President, *J. W. Backus*
Vice President, *Alexander Christie*
Secretary-Treasurer, *Vernon E. Grant*
Librarian, *A. N. Austin*

Board of Managers, *C. A. Kohrs, E. A. Wilch* and *W. E. Bancroft.*

Delegates to the convention: *Jos. Pietro, N. Promisel, E. A. Wilch;* alternates: *Jos. St. Pierre, J. W. Backus* and *C. A. Kohrs.*

Milwaukee Branch

The following officers were elected at the May 4th meeting:

President, *Jack Geissman*
Vice President, *Rodney Olsen*
Secretary-Treasurer, *Robert Goodsell*
Librarian, *Henry Bornitzke*
Board of Managers, *Dan Wittig, Vincent Sheehan, A. J. Hermansen.*

Delegates to the Convention: *R. M. Goodsell, Harry Unke, Rodney Olsen;* alternates, *Roman Binder, Dan Wittig, Robert Steuernagel, Sr.*

New Haven Branch

At the business meeting of the New Haven Branch on May 9th the following officers were elected:

President, *Henry Creamer*
Vice President, *T. H. Chamberlain*
Librarian, *Joseph Sullivan*
Secretary-Treasurer, *Robert Gray*
Assistant Secretary & Treasurer, *Clarence Garner.*

Board of Governors: *John Oberender, George Knecht, Henry Smith, Joseph Downes* (retiring president).

Delegates to National Convention: *T. H. Chamberlain, Joseph Downes, Al Jackle.* Alternates: *Wm. Bridgett, James Hines, Joseph Sexton.*

E. A. Anderson, chief of the Metal Section of the Research Dept., N. J. Zinc Co., Palmerton, Pa., spoke June 6 on the "Finishing of Zinc Base Die Castings."

T. H. Chamberlain was technical chairman.

Chas. Koelbl, was chairman of the Stag Dinner held by the chemistry class on Saturday evening, June 3rd.

New York Branch

At the April 28th meeting, the following officers were elected:

President, *Ralph J. Liguori* (fifth term)
Vice President, *Justus Stremel*
Secretary-Treasurer, *F. J. MacStoker*
Recording Secretary, *Henry Painter*
Librarian, *Dr. C. B. F. Young*
Trustees: *Ben Nadel, John E. Sterling* and *Ben Popper.*

Delegates to the Asbury Park Convention: *R. J. Liguori, F. J. MacStoker* and *Justus Stremel.*

At the first May meeting, a social hour with refreshments was held following the installation of the officers.

The meeting held on May 26th, consisted of a round-table discussion on current plating problems.

Pittsburgh Branch

At the May 6th meeting, the following officers were elected for the year 1939-1940:

President, *S. E. Hedden*
Vice President, *Mr. Peter*
Secretary-Treasurer, *Frank Keller*
Delegates: *N. H. McKay, John Corbit, S. E. Hedden.*

Toledo Branch

At the April 27th meeting, the following officers were elected:

President, *Vic. Miner*
Vice President, *S. C. Shank*
Secretary, *Gaston Bergeman*
Treasurer, *Edward St. Arnand*
Librarian, *Stanley Moore*
Board of Managers: Messrs. *Hale, Weiker* and *Stegeman*
Delegates to the Convention: *G. Bergeman, Lester Cope* and *Ward Hunlock;* alternate: *James Nagle, Jr.*

The program of the national convention is in front part of issue.

The Electrochemical Society Fellowship in Electrochemistry Awarded to W. P. Ruemmler

The Electrochemical Society has just awarded the eleventh *Weston Fellowship* of $1,000.00 to *Waldemar P. Ruemmler* of St. Louis, Missouri. Mr. Ruemmler will continue his research at Columbia University, investigating the electrodeposition of antimony. The work will be done under the direction of *Professor Colin G. Fink.*

Previous holders of the Weston Fellowship are:

Edward B. Sanigar of Sheffield, England.
Karl Sollner, of Berlin, Germany.
Marlin E. Fogle of Iowa (2 years).
Robert D. Blue of Indiana.
Pierre A. Jacquet of Paris, France.
Myron A. Coler of New York City.
Henry B. Linford of Seattle, Washington.
Garth L. Putnam of Seattle, Washington.
Vittorio de Nora of Milano, Italy.

The Fellowship was founded by *Dr. Edward Weston*, a foremost pioneer in electrochemistry.

Dr. H. Jermain Creighton The Electrochemical Society's New President

Dr. H. Jermain Creighton, newly elected President of the Electrochemical Society, was born in Dartmouth, Nova Scotia, on March 2, 1886. He attended Dalhousie University at Halifax, Nova Scotia, receiving his Bachelor of Arts degree in 1906 and his Master of Arts degree in 1907. He then received a fellowship and spent the next two years at Birmingham, England, receiving his Master of Science degree there in 1909. He next spent a year at Heidelberg University and another year at the Polytechnikum at Zurich, Switzerland, where he obtained his Doctor of Science degree. Returning to Dalhousie University, he lectured on physical chemistry until 1912 when he was invited to Swarthmore College, Pennsylvania. He has headed the Chemistry Department of Swarthmore since 1928. The Franklin Institute awarded him the Longstreth Medal in 1918. He is the author of one of the very best books on electrochemistry, which is used in many American and British universities.

Not only is Dr. Creighton one of the foremost teachers of electrochemistry, but he is also the inventor of a commercial process for the production of alcohol from sugar by electrolytic reduction. By his process, for example, glucose is converted into sorbitol. Sorbitol has two principal values: first, as a moistening and softening agent; secondly, sorbitol is an intermediate in chemical synthesis. The most important derivatives at present is ascorbic acid (vitamin C). Dr. Creighton has just been awarded the Howard N. Potts gold medal, "in consideration of his distinguished work in developing a process for the electrolytic reduction of simple sugars on a commercial scale."

Miccro Supreme STOP-OFF LACQUERS

Developed and Manufactured by Experienced Platers

—UNSURPASSED— For Insulating Plating Racks

For Masking Parts For Hard Chromium Plating And Other Protective Purposes

• Miccro Supreme Stop-Off Lacquers —introduced only a year ago—are, today, in constant use in hundreds of the country's leading plating plants and departments. They have proved, without question, their exceptional economy and practicability in use for insulating plating racks, for masking parts for hard chromium plating and for various protective purposes such as for tank coatings, insulating bus-bars, protecting ventilating systems, etc.

Miccro Supreme Stop-Off Lacquers can be obtained as red or black pigmented lacquers or in a crystal-clear non-pigmented form. They are applied *directly on the metal surface.* They always provide a perfectly uniform coating that can be depended upon to give excellent insulating service. Be sure to have complete information. WRITE TODAY.

Effective In Many Solutions

Have proved to be practically unaffected through regular cycle of decorative plating. Tests with alkaline cleaner at 212 degrees F. showed the coating still effective after 500 hours of continuous immersion. Coatings are also unaffected by concentrated or diluted hydrochloric or sulphuric acid, cyanide or acid copper solutions, standard or bright nickel and chromic acid baths. They are impervious to nitric and hydrofluoric acids. They can be used with degreasing units.

When used for masking parts, sharp, clean edges can always be secured.

MICHIGAN CHROME COMPANY
6348 East Jefferson Avenue · Detroit, Michigan

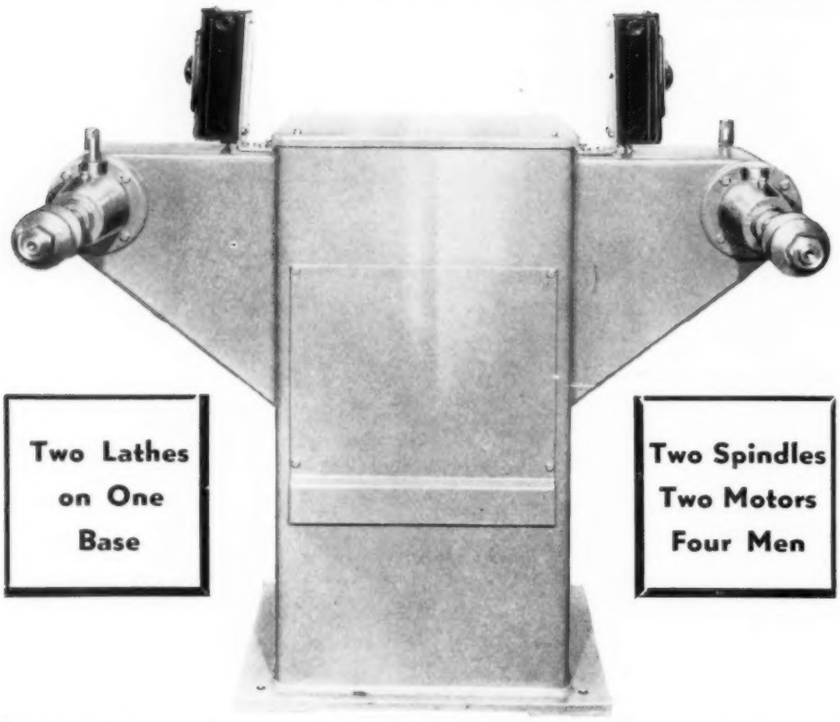
The announcement of the sixth award of the Edward Goodrich Acheson medal and $1,000 prize to *Dr. Francis Cowles Frary* was made at the Electrochemical Society meeting at Columbus, Ohio, Wednesday, April 26th. Previous recipients of this highest recognition in electrochemistry are: *Dr. Edward Goodrich Acheson*, for his work on artificial graphite; *Dr. Edwin F. Northrup*, for the invention of the high frequency electric furnace; *Dr. Colin G. Fink*, for his contributions to electrochemistry; *Dr. Frank J. Tone*, for his work on carborundum; and *Dr. Frederick M. Becket*, for his contributions to electrometallurgy.

Dr. Frary is the director of the Research Laboratories of the Aluminum Company of America and he is well known for his achievements in the metallurgy of aluminum. The so-called Frary metal is a tin-free, bearing metal used extensively in place of babbitt.

During the Great War he was Captain of the Ordnance Department, Officers Reserve Corps, and Major in the Chemical Warfare Service. He is a Past-President of the Electrochemical Society and has contributed a number of important papers on the electrometallurgy of aluminum.

The *Electrochemical Society*, in convention at Columbus, Ohio, awarded to *Nathaniel B. Nichols* of Ann Arbor, Michigan, The Society's *Prize to Young Authors*, for the paper published jointly by *Dr. L. A. Matheson* and *Mr. Nichols* entitled, "The Cathode Ray Oscillograph Applied to the Dropping Mercury Electrode." Mr. Nichols is a Research Associate at the University of Michigan, Ann Arbor, Michigan.

THE SPACE SAVER!



Two Lathes on One Base

Two Spindles Two Motors Four Men

Add the Second Lathe in this Floor Space

Install a Standard Single Spindle Lathe in this Floor Space

Crown Rheostat & Supply Co.

Complete Plating and Polishing Equipment

1910 Maypole Ave. Chicago, Ill.

The Fourth Annual Forum of the Porcelain Enamel Institute will be held at Ohio State University, Columbus, on October 18, 19, and 20, according to an announcement by Frank E. Hodek, Jr., General Porcelain Enameling & Mfg. Co., Chairman of the Forum Committee.

Details of the program will be announced later. However, the subjects under consideration by the Forum Committee assure a varied and thorough coverage of current problems that will interest shop men in the porcelain enameling industry and related industries. Papers presented by authorities in various fields will be followed by discussion in the manner that has made previous Forum sessions so valuable in standardizing and improving enameling shop practice.

Meeting of Research Committee

The Joint Committee on Exposure Tests of Plated Coatings on Non-Ferrous Metals, held a meeting May 12th at the Bell Telephone Laboratories in New York, to discuss the publication of data secured by the exposure tests.

The members of the Joint Committee present were:

E. A. Anderson
B. H. McGar
W. A. Wesley
A. W. Tracy (for J. R. Freeman, Jr.)
C. E. Heussner
C. H. Sample
W. Blum

The following visitors attended the meeting:

A. M. Austin	W. R. Meyer
Wm. E. Baulieu	E. V. Mott
K. Bellinger	C. F. Nixon
B. M. Crum	E. J. Roehl
Jos. L. Downes	H. B. Smith
W. J. R. Kennedy	Erwin Sohn
R. J. McKay	T. J. Wieczorek

Dr. Wm. Blum of the Bureau of Standards, was chairman.

Obituaries

Otto Halmbacher

Otto Halmbacher, 67, foreman of the electroplating department of the Mueller Co., Decatur, Ill., for twenty-five years, died in St. Mary's Hospital, where he was taken after suffering a heart attack. He had been in failing health since 1935.

Mr. Halmbacher was born in Decatur, June 9, 1871, and spent his entire life there. He was married in Decatur to Anna Eberle of Indianapolis.

After retiring in 1935, due to ill health, Mr. Halmbacher operated an electroplating shop in his home. He was able to attend the platers' convention in Milwaukee last June and enjoyed every moment at the sessions and meeting old friends.

Besides his wife he leaves a son, Paul, of Milwaukee, a brother, Max, of Oklahoma City, and a nephew, Max Butzbach of Gary, Ind.

Joseph Farrell

Joseph Farrell, for the past 16 years a mechanical engineer associated with the Seth Thomas Clock Co., Thomaston, Conn., died March 24 following a brief illness.

Col. Samuel Mowry Nicholson

Col. Samuel Mowry Nicholson, president of the Nicholson File Co., and the American Screw Co., Providence, R. I., died April 7 at his home in that city after an illness of several months. He was 78 years of age.

Col. Nicholson was born in Providence in 1861 and in 1879 entered the employ of the file company of which his father the late William T. Nicholson was founder and president. He progressed in both shop and accounting phases of the business and in 1881 was made secretary, in 1890 a director, in 1891 vice-president, and on the death of his father in 1893, succeeded him as president and general manager.

Edward Gray

Edward Gray, former chief engineer for the Ford Motor Co., died in Detroit April 3 following a short illness. Mr. Gray was 66 years of age.

Verified Business Items

Tolhurst Centrifugal Division of the American Machine & Metals, Inc., have transferred their general sales offices to East Moline, Ill., where the manufacturing plants of this company are located. Also included in this move is the advertising department. The central location of the E. Moline factory and sales office will facilitate handling customers' inquiries. This Division was formerly located at 100 Sixth Avenue, New York City.

Maas and Waldstein Co., announces removal of its Chicago office and warehouse to 1658 Carroll Avenue, Chicago. The new plant will have additional space and facilities to provide for the increased business in the mid-western territory serviced by this division. This office and warehouse was formerly located at 1336 Washington Blvd.

Alumaweld Co. of America has changed its name to *Lloyd S. Johnson Co.*, and is located at 2241 Indiana Ave., Chicago, Ill. This firm was formerly at 2442 S. Park Way, Chicago.

John Kavaf, is now located at 226 Eddy St., Providence, R. I., having formerly been at 3 Mathewson St. This firm does gold, silver and nickel plating, and coloring of all kinds of jewelry.

Oakite Products, Inc., 22 Thames St., New York City, are celebrating their 30th year of service to industry. Oakite Products, Inc., was founded in 1909.

Solar Aircraft Co., 1212 W. Juniper St., San Diego, Calif., plans one-story addition, 170 x 180 ft., for parts production and assembling. Cost over $85,000 with equipment. Departments: rolling, drawing, pickling, stamping, soldering, brazing, welding, grinding, sand-blasting, descaling, polishing, degreasing, cleaning, tumbling, buffing, anodic treatment. Principal metal used: stainless steel.

Acme Galvanizing Inc., Milwaukee, Wis., plant which is at 906 E. Bay St., was destroyed by fire, has purchased buildings at S. 19th St. & W. Cleveland Ave., Milwaukee, and has remodeled 17,650 sq. ft., of floor space, with 13,400 sq. ft. available for future use. New equipment will be installed. In addition to doing custom galvanizing, solder dipping, cadmium plating, etc., it will start a new line of hard chrome plating. *I. M. Herrmann* is president. Departments: plating, galvanizing. Principal base metals used: zinc and lead.

Spencer Lens Co., Scientific Instrument Division of the American Optical Co., Buffalo, N. Y., has elected the following officers: *H. N. Ott*, chairman of the Board of Directors; *B. H. Witherspoon*, president and general manager; *H. D. Rhynedance*, vice-president and general sales manager; *B. Glenny*, treasurer, and *C. W. Barton*, secretary and manager of Research & Development. As chairman of the board, Mr. Ott, who has been president since 1919, relinquishes active executive responsibilities.

A. J. Wadhams, Vice-President of the *International Nickel Co., Inc.*, and manager of the Development and Research Division, has announced the establishment of a new field office located at 67 Wall Street, New York, N. Y.

The new office, which was opened May 1st, is under the direction of *J. W. Sands*. Its main function will be to promote the use of nickel alloy steels and stimulate interest in products of the Huntington Mill, nickel cast irons and the use of nickel in non-ferrous alloys.

The territory covered by this office includes Metropolitan New York, Long Island, New Jersey; Pennsylvania, east of Williamsport, Harrisburg, York; Delaware, Maryland, Virginia, and the District of Columbia.

The industrial division of *The DeVilbiss Company* has moved its New York sales and service branch to 111 Eighth Avenue in the Port Authority Commerce Building.

Improved transportation, trucking, and parking facilities are available in this new location. Its greater accessibility will, company officials believe, make the service facilities offered by this branch more convenient to the trade.

for Lasting Rust and Tarnish Resistance

Dip! or Spray! and Bake!

SPEKALUMINITE

Trade Mark Reg.

The Modern ALUMINUM COATING on CAST and FABRICATED Products

Features

COSTS LESS than Electroplating

DECORATIVE White Finish. Beautiful Soft Color

80% REFLECTIVITY of Silver

FLEXIBLE Hard Finish

WILL NOT PEEL or FLAKE

TARNISH and RUST RESISTANT

ONE COAT DIP WITHSTANDS SALT SPRAY

on Cast Iron—196 hours
on Rolled Sheet Steel—72 hours

LOWER in COST! . GREATER in BEAUTY!

Adheres perfectly to all metals, glass, gutta percha, etc. Try it and see for yourself how SPEKALUMINITE can cut your costs and give you a far superior decorative and rust resistant finish that is Flexible, Durable and can be bent or formed without cracking or peeling. Requires no expensive equipment—just a baking oven. Investigate further its money saving advantages.

Send today for a trial supply of SPEKALUMINITE (Special quart container $2.00)—test its superior features under your own plant conditions or send samples to be SPEKALUMINITE finished by us.

Price Schedule on request.

SPECIAL CHEMICALS CORP.
30 IRVING PLACE . NEW YORK, N. Y.

QUALITY SPEC PRODUCTS

The Chicago Pulley & Shafting Co., 17-23 N. Desplaines St., Chicago, Ill., has been appointed distributor of Ajax flexible couplings.

Hub Paint and Varnish Corp., 7 Wythe Ave., Brooklyn, N. Y., has leased one-story building at Fifth Street and Forty-seventh Rd., L. I. City, N. Y., about 11,000 sq. ft. of floor space for plant.

Magnus Chemical Company Holds Sales Conference

The Magnus Chemical Co., Inc., held its annual eastern sales conference at the Winfield Scott Hotel, Elizabeth, N. J., May 4th, 5th and 6th. The conference, the largest regional meeting ever held by the company was attended by over 45 members of the field organization and executives of the home office.

The program of the conference sessions was designed to bring out very clearly leading points of work included in the industrial cleaning field. Various members of the sales staff presented different phases of cleaning work and demonstrated how the company's materials fit in with the problems and requirements of certain cleaning operations.

Among the subjects discussed included problems of the automotive service field, motor cleaning, floor cleaning, sludge removal, cleaning in bakeries and dairies, cold tank cleaning and general cleaning.

Many improvements made in existing products and a number of new products were described in detail. It was shown how these new materials worked under conditions approximating those encountered in the field.

Sales records, the advertising and sales promotion program for the year, as well as several interesting sales movies, were included in what was termed a most interesting program.

The sales force represented included those from the eastern parts of the country. A similar mid-western conference was held June 1st, 2nd and 3rd at the Hotel Sherman, Chicago. Other meetings will be held in the south and west.

Members of field organization and executives of Magnus Chemical Co., Inc.

Walker's
CLEAR HARDWARE
LACQUER No. 702

Recommended for outdoor durability, having extreme non-greening qualities, as well as perspiration resistance.

H. V. WALKER Co.

ELIZABETH NEW JERSEY

FINISHES TO FIT THE PRODUCT

New England Warehouse
Brown and Dean, Providence, R. I.

Monarch Aluminum Mfg. Company Opens New Division for Production of Die Castings and Manufacture of Die Casting Machines

Raymond Deutsch, president and treasurer of Monarch Aluminum Mfg. Co., Detroit Ave. & W. 93rd St., Cleveland, Ohio, recently announced the addition of their Dycast Products Division with *David Benjamin* as general manager of this Division.

Mr. Benjamin was formerly associated with the Gabriel Co. of Cleveland, manufacturers of Gabriel snubbers and automobile accessories, for twenty-seven years as secretary-treasurer and director. In 1934, he founded Pressure Castings, Inc., of which he was pres. and secretary-treasurer. The Dycast Products Division is equipped to produce die castings from aluminum and zinc alloys. Their plant is modern in every respect and the die casting equipment consists of the latest and most efficient high pressure type die casting machines which are of their own design and manufacture. These machines have a capacity for producing castings weighing up to sixteen pounds each and with a surface area of approximately 300 sq. in.

The organization of the Dycast Products Division consists of men who have had many years of die casting experience both from an engineering and production standpoint. These men pioneered high pressure die casting of zinc and aluminum alloys in the industry. *M. N. Suvak*, chief engineer, is well known in the trade.

Monarch Aluminum Mfg. Company is also a producer of permanent mold castings from aluminum alloys. The company produces a full line of cast aluminum kitchen utensils, also agitators for washing machines, parts for vacuum cleaner, waffle irons, etc. They have in their employ up to 1,000 people and are among the largest users of ingot aluminum in the country.

The officers of Monarch Aluminum Mfg. Company in addition to Raymond Deutsch, are *Harold J. Deutsch*, vice-president and *David R. Gould*, secretary.

Monarch has been in business over 26 years. They are located in their own building which was recently purchased at above address. This modern fire-proof building contains approximately 300,000 sq. ft. of floor space and is situated on 5½ acres of land on the Nickel Plate Railroad with sidings into the property.

The metallurgical and chemical laboratory of the company is in charge of *Alfred Sugar*, who is well known in the metal industry. Mr. Sugar is secretary of Sub-Committee No. 1 of Committee B-7 of A.S.T.M. He is also a member of A.I.M.E. and A.S.M. Both the die-casting and permanent mold foundries are under the technical control of the laboratory.

Maas & Waldstein Company, makers of industrial finishes, Newark, New Jersey, announces the appointment of *A. W. Keller* as a technical sales representative.

Mr. Keller was formerly with Maas & Waldstein, having served as a sales representative for nine years. He has had wide experience in all phases of industrial finishing, and is well known to Eastern manufacturers, especially in the New York and New Jersey metropolitan areas.

MADE TO ORDER
for Modern Design

Product need modernizing? Here are stripes, scorings, crimpings and corrugations as up-to-the-minute as next year's automobiles. Colors? Four lustrous ones —red, yellow, green and gold—in addition to the standard finishes. Costly? These metals bring *production savings!* They're *pre-finished*—eliminate all plating and polishing operations. Get the whole story. Write on your company letterhead for a new booklet illustrating all metals and scores of design ideas.

AMERICAN NICKELOID COMPANY
8 Second Street, Peru, Illinois
Sales Offices in All Principal Cities

√ *CHECK*

LUPOMATIC
EQUIPMENT
COMPOUNDS
PROCESS

The ideal setup for your finishing dept. Lupomatic's completely automatic, inexpensive simple method of finishing metal parts of every description will enable you to:—

IMPROVE THE APPEARANCE OF YOUR PRODUCT
INCREASE YOUR OUTPUT AND
BRING YOU *EXTRA PROFITS*

Complete Data On Your Requirements Will Be Given Without Obligation. Write

LUPOMATIC TUMBLING MACHINE CO., INC.
4515 Bronx Blvd. New York, N. Y.

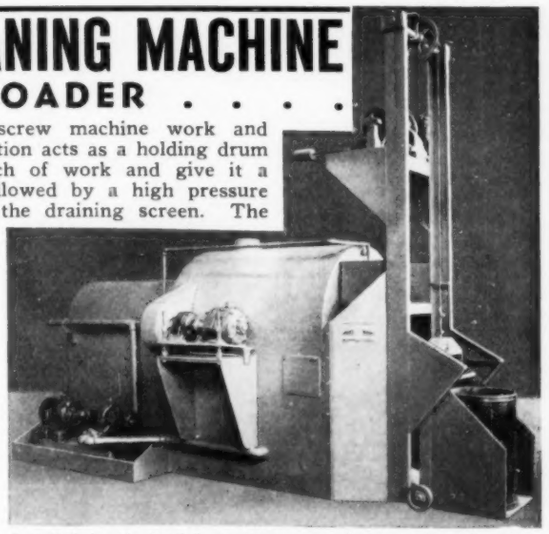
METAL CLEANING MACHINE
with POWER LOADER . . . .

For cleaning stampings, screw machine work and similar parts. The first section acts as a holding drum to receive a complete batch of work and give it a soaking wash. This is followed by a high pressure spray wash and drain in the draining screen. The combination results in extremely clean work.

Bring your cleaning, washing, rinsing, drying, and burnishing problems to Ransohoff—pioneers in the manufacture of Metal Cleaning Machinery. Write for new catalog.

IDEAL
TRADE MARK REG. U.S. PAT. OFF.

N. RANSOHOFF, Inc.
202 West 71st St., Carthage
Cincinnati, Ohio



Installed in plant of large motor manufacturer, Detroit, Mich.

THE ROBERTS ROUGE COMPANY

Factory
247 Connecticut Ave., Bridgeport, Conn.

Manufacturers of: **Gold, Silver Plate, and Sterling Rouges, Chromes, Stainless Steel, and Crocus Compounds.**

Greetings Electroplaters:

Your expression of confidence and interest in our products is appreciated.

Our new company was born with the desire to supply a uniform controlled product for the industry and from the acceptance by the trade, we feel that we have not failed.

Many thanks,

Ted Oukey

felt

FOR POLISHING TOUGH *Shapes*

The face of a Paramount Felt Polishing Wheel can be turned to fit the job, *and it stays there!* No spreading like built-up wheels do, requiring constant reheadings.

Ask your supplies salesman for PARAMOUNT BRAND.

BACON FELT CO.

WINCHESTER, MASS. ESTABLISHED 1824

FILTERS *Portable or Stationary*

Capacity—200 to 2400 Gallons Per Hour

For:-

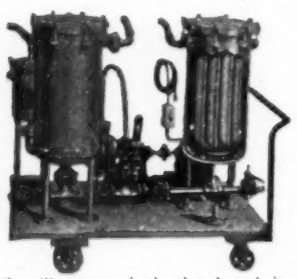
- NICKEL & BRIGHT NICKEL
- CHROMIUM
- ACID COPPER
- ZINC & BRITE ZINC
- CYANIDE COPPER & BRASS
- CADMIUM & TIN
- ELECTROCOLOR
- AND OTHER PLATING SOLUTIONS

— Also For —

DEGREASING SOLVENTS, CLEANERS, NEUTRALIZING SOLUTION, ETC.

Many important benefits are derived, and big savings effected in metal cleaning operations, as a result of filtration.

Industrial Filter & Pump Mfg. Co.
3017 West Carroll Avenue Chicago, Ill.



Cut illustrates both closed and internal view of typical filtering unit.

FILTERS for BRIGHT NICKEL are now offered in "Seven" new types and—"Eleven" different sizes.

For specific recommendations, mention kind of solution, number of gallons, etc. Write for our new bulletin and Descriptive literature.

Personals

Paul Strausser Joins Frederic B. Stevens, Inc.

Paul W. C. Strausser has recently resigned from the Bureau of Standards, to accept a position with Frederic B. Stevens, Inc., Detroit, Mich. He will take over the sales and servicing of plating supplies and equipment for the Detroit area. Having spent about 15 years in Detroit, Mr. Strausser returns to renew contacts with many of his friends and business associates which he made prior to leaving for Washington, D. C.

Mr. Strausser was born on April 23, 1893 in Reading, Pa. After leaving school, his first job was that of laboratory assistant with the Reading Iron Co., Reading, Pa. Several years later, he made a connection with the Illinois Steel Co., Gary, Ind., working through the routine of their main and coke laboratories. Having gained

Paul W. C. Strausser

a general knowledge of steel practice, he later went with the Ford Motor Co., Detroit, as general analyst. In 1918, he accepted a position with the General Motors Corporation research laboratories, having been assigned to metallurgical and electroplating research. It was here where he did considerable experimental work on chromium deposition, working under the supervision of W. M. Phillips, now president of the American Electroplaters' Society.

In 1925, his efforts were further realized by joining the Chrysler Motor Corp., being assigned to engineering problems on metal finishes. In 1930, Mr. Strausser was appointed research associate for the American Electroplaters' Society with headquarters at the National Bureau of Standards. This work was under the direct supervision of Dr. Blum. One of the important projects selected for study was the "Protective Value of Electrodeposits on Ferrous and Non-Ferrous Basis Metals." Valuable data were obtained from the outdoor ex-

posure of several thousand plated specimens in seacoast, rural and industrial regions of the country.

In connection with the outdoor exposure tests, a thorough study was made of accelerated tests. These tests are important in that they serve as a guide or yardstick in predicting the probable life of a given coating when used under normal conditions. A study of stripping and dropping tests for determining the average and local thickness of the different coatings used in the plating program was also studied. Of these, the well known Hull and Strausser test for determining the local thickness of zinc and cadmium coatings was formulated. Several publications have been issued covering the A.E.S. work since it was instigated.

Dr. Stareck Awarded Longstreth Medal

Dr. Jesse E. Stareck, now engaged in research at the laboratories of United Chromium, Incorporated, Waterbury, Conn., on May 17th received the Edward Longstreth medal of the Franklin Institute in Philadelphia for his discovery of electrolytic color painting, a new method applicable to the art of coloring metals. This process has been made available commercially by United Chromium, Incorporated and has found widespread use for the production of "Electrocolor" articles.

Dr. Stareck was born in Petersberg, Michigan. He spent most of his youth in Benton, Kansas and then entered the University of Kansas from which institution he was graduated in 1928. Subsequent to graduation, he served as an instructor in the Chemistry Department at the University, receiving his degree of Master of Science in 1931 and his Ph.D. degree at the same institution in 1934. His next year was spent as a member of the staff of the Kansas City Testing Laboratory, Kansas City, Mo. and since 1935 he has been carrying on his work on the further development of electrolytic color plating at the Waterbury laboratories of United Chromium, Incorporated.

Louis M. Hague was recently appointed Vice President in Charge of Sales of Hanson-Van Winkle-Munning Company, Matawan, N. J. *C. W. Yerger*, formerly Vice President and Sales Manager has been appointed Executive Vice President.

E. Cohan, president, Cohan-Epner Co. Inc., 142 W. 14th St., New York City, left on April 21st for a vacation in Florida. The Cohan-Epner Co., is now in its 28th year of continuous operation. This firm does contract electroplating and finishing; specializing in jewelry, novelties and allied products.

William G. Lind, charter member of the Metal Finding Manufacturers Association, Providence, R. I., was elected president of that association at its annual meeting, May 3rd. The business session of the meeting was preceded by a luncheon, served at the Hotel Narragansett, Providence. Other officers elected to serve with Mr. Lind were: *J. P. Whitaker*, vice-president; *W. A. H. Wells*, secretary; *Arthur E. Leach*, treasurer. The term of officers is for the ensuing

TRULY—THREE GREAT FINISHES!!

CHROMIUM - UDYLITE - SHERARDIZING

SHERARDIZED

1910 TRADE MARK 1939

For over a quarter of a century building and installing portable sherardizing furnaces and equipment; metal finishing and plating. We invite your inquiry.

THE

NATIONAL SHERARDIZING & MACHINE CO.

OFFICE & FACTORY HARTFORD, CONN.

Foreign Representatives—OLIVER BROS., INC., 417 Canal St., N. Y. City

"Speedip"

WHIRL ENAMELER

Saves Time — Saves Enamel

● A combination dipping-whirling machine for completely coating large quantities of small parts with lacquer, enamel, paint, etc.

All operations are within the machine. Parts are dipped into coating material, raised and whirled. Time as little as 30 seconds. Speeds up production—cuts finishing costs—saves lacquers and enamels.

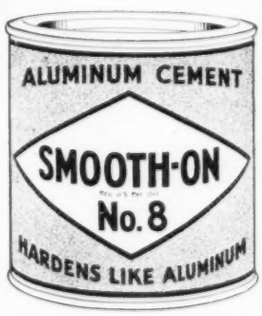
Write for further details or send samples to be coated.

RONCI MACHINE COMPANY

45 RIVER AVENUE • PROVIDENCE, R. I.

Filling cement for ALUMINUM

SMOOTH-ON NO. 8



THIS cement is easily applied, adheres and hardens well, matches the color and surface texture of the surrounding metal, and can be filed, machined or polished to a fine finish.

As a filling for holes, rough surface or porous spots on castings, and for seams, cracks and open spaces between assembled parts, this composition gives the same satisfaction on aluminum as do the three grades of Smooth-On No. 4 Iron Cement on iron and steel surfaces.

The first application will prove its desirability for the purposes intended, and the saving of a few otherwise rejected pieces pays for all the cement required in a year. Make the trial and be convinced. The cost is almost nothing. Get free samples and see for yourself.

Buy Smooth-On No. 8 in ⅛-lb. or 1-lb. can.

SMOOTH-ON MFG. CO., Dept. 18, 568-574 Communipaw Ave., Jersey City, N. J.

Do it with **SMOOTH-ON**

year to May 1940. Mr. Lind succeeds *James J. Corrigan*, who has been president for the past year. Mr. Lind has had considerable knowledge of jewelers' affairs and trade association work, having been active in affairs of the New England Manufacturing Jewelers' and Silversmiths' Association for over 30 years, and of which he is second vice-president. Mr. Lind is treasurer and general manager of T. W. Lind Company.

G. A. Lux has been engaged as technical director for the Lustre Chemical Corp., Rochester, N. Y. Mr. Lux has been chief chemist for the past twelve years at the General Railway Signal Co., Rochester, N. Y.

C. B. Robinson was elected president, and *W. F. Torrey*, secretary-treasurer, at the annual directors meeting of the J. B. Ford Sales Company, Wyandotte, Mich. Mr. Robinson has been connected with the Wyandotte organization in a sales and executive capacity for twenty-two years, the past ten years occupying the post of general manager. Mr. Torrey likewise has had Wyandotte sales experience, and has been actively connected with the J. B. Ford organization for six years.

T. E. Barlow has been appointed metallurgical engineer of the *Copper, Iron and Steel Development Association*, with headquarters in Cleveland. He will act as technical service representative of the association of copper producers, whose aim is to direct the increasing tonnage of copper employed in iron and steel to the best possible advantage.

Since 1936 Mr. Barlow has been a research engineer at Battelle Institute.

Charles Knupfer, Vice-President and General Sales Manager of *The Carborundum Company*, Niagara Falls, N. Y. announces the appointment of *John Storm* as District Sales Manager at New York, N. Y. Mr. Storm's headquarters will be at the company's branch warehouse and sales offices, 601 West 26th Street. He will be in charge of the company's sales activities in the Metropolitan New York area.

Mr. Storm succeeds *Frank J. Harrington* who has been transferred to the Sales Department at the main office of the Company at Niagara Falls, N. Y. Previously Mr. Storm had been a member of the sales staff at the Detroit branch warehouse and sales office.

STAINLESS STEEL POLISHING COMPOUNDS

If It's Stainless Steel Polishing It's a "4-A" Job

It's been proved every day in every kind of metal working plant: "4-A" Polishing Compounds are faster, more efficient and more economical for cutting down, polishing and mirror finishing all kinds of steel, including stainless and radium.

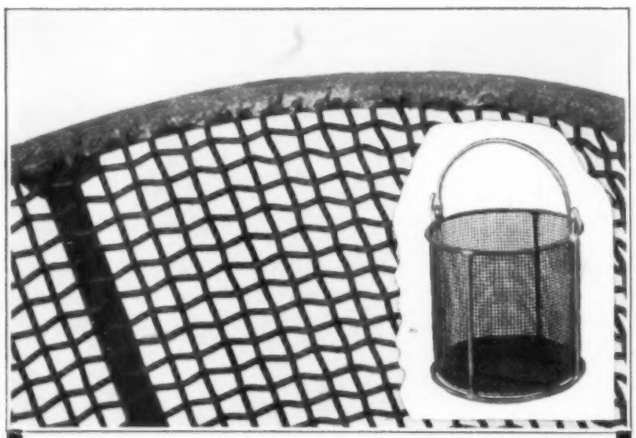
CEMENT AND THINNER

Use it with any kind of wheel —soft, medium or hard—and the results will speak more eloquently than anything we could say.

Tell us about your toughest job, and we'll be glad to send the "4-A" product that will solve your problem No obligation, of course

Instead of glue, use "4-A" Cement and Thinner, a uniform substitute for polishing Wheels, Belts, Buffs, Rolls, etc Samples of Compound or Cement sent on request

HARRISON & COMPANY HAVERHILL, MASS.



WELDED BASKETS

Nickel Chrome
Monel Metal
Stainless Steel
Plain Steel

Rolock welded baskets cost less because they last longer. Sturdy frames protect the mesh and take the wear. They are economical, efficient and quickly obtainable.

Send specifications for prices.

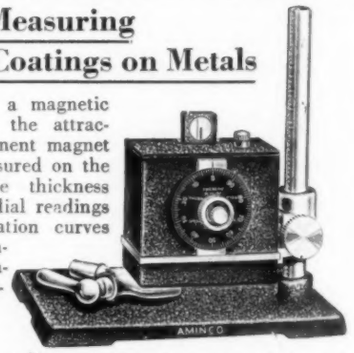
ROLOCK, INC.
19 STATION ST. • SOUTHPORT, CONN.

AMINCO

Aminco-Brenner
MAGNE-GAGE

For Measuring
Thickness of Coatings on Metals

THIS instrument is a magnetic balance by which the attraction of a small permanent magnet to any surface is measured on the graduated dial. The thickness corresponding to the dial readings are shown on calibration curves prepared for each instrument by the National Bureau of Standards.



Has three distinct applications in measuring thickness of coatings:

1. Nickel Coatings on non-magnetic base metals such as copper, brass and zinc.
2. Non-magnetic Coatings which may be metallic (copper, zinc, cadmium, tin, lead or chromium), or non-metallic (paint, varnish, lacquer or enamel) on magnetic base metals such as iron or steel.
3. Nickel Coatings on iron or steel.

- Non-destructive of the coatings or the specimen tested, thus effecting great savings.
- Reliable within ± 10%.
- Ideal for works control or acceptance testing.
- Measurements made rapidly with little experience.
- Equally applicable to plane, convex or concave surfaces.
- Compact—weighs only 7½ lbs.

Inquiries should state nature of base metal, also type and thickness of coatings to be measured.

Write for Bulletin 1070 MI

AMERICAN INSTRUMENT CO.
8010-8020 Georgia Ave. Silver Spring, Md.

Tom Addison has been appointed chief designing engineer of the Defiance Machine Works, Defiance, Ohio. Mr. Addison comes to the Defiance organization from Cincinnati, where he served as design head and engineer for a number of important tool companies.

Mr. Addison was born in England and received his academic technical training at Sunderland Technical College. After graduating from this institution, he worked a number of years in his native country acquiring practical experience. He came to the United States in 1911.

Russell A. Blanchard, connected with the Detroit Brass & Malleable Works, Detroit, Mich., for fourteen years, has been appointed Detroit district sales representative of Extruded Metals, Inc., Belding, Mich.

T. F. Onkey President of Roberts Rouge Co.

Theodore F. Onkey

Theodore F. Onkey has recently become president of Roberts Rouge Co., Bridgeport, Conn. Mr. Onkey was formerly associated with the Oriental Rouge Co., Bridgeport.

He is well known in the buffing industry throughout Connecticut, having serviced this industry for many years.

Francis J. Comer also formerly with the Oriental Rouge Co., is treasurer of the Roberts Rouge Co.

Offices and factory of Roberts Rouge Co., Bridgeport, Conn.

Polish Your Stainless Sheets & Strip Steel

for your job in process to your required finish by the Excelsior Method. Reduce your inventory, avoid delay and save 75% extra cost for No. 4 Finish.

For full particulars address

EXCELSIOR TOOL & MACHINE CO.

East St. Louis, Illinois

PERMAG Cleaning Compounds are produced by

MAGNUSON

Products Corporation

Main Office and Factory

Third & Hoyt Sts., Brooklyn, N. Y.

Warehouses in Principal Cities.

In Canada: Canadian Permag Products Ltd. Montreal and Toronto

PERMAG

CLEANING

COMPOUNDS

PERMAG Cleaning Compounds are backed by many years of successful experience in producing cleaning compounds for the metal industry.

Coupled with Magnuson Research, the solution to the hardest cleaning problems are found quickly and worked out economically.

Write us about your cleaning difficulties. We can help you.

Supply Prices, June 1, 1939

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER: Cast	20⅜c. per lb.	
Electrolytic, full size, 15⅜c.; cut to size	15⅜c. per lb.	
Rolled oval, straight, 15⅞c.; curved	16⅛c. per lb.	
BRASS: Cast	17¼c. per lb.	
ZINC: Cast	10 c. per lb.	
NICKEL: 90-92%, 16″ and over	.45 per lb.	
95-97%, 16″ " "	.46 per lb.	
99%+cast, 16″ and over, 47c.; rolled, depolarized, 16″ and over, 48c.		
SILVER: Rolled silver anodes .999 fine were quoted from 46c. per Troy ounce upward, depending on quantity.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.06¼
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16¾-.17¼
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027
Hydrochloric, C.P., 20°, carboys	lb.	.08
Hydrofluoric, 30%, bbls.	lb.	.07-.08
Nitric, 36°, carboys	lb.	.06
Nitric, 42°, carboys	lb.	.075
Oleic (Red Oil), distilled, drums	lb.	.08⅜
Oxalic, bbls. l.c.l.	lb.	.12-.14
Stearic, double pressed, distilled, bags	lb.	.10½-.11½
single pressed, bags	lb.	.10-.11
triple pressed bags	lb.	.13½-.14½
Sulphuric, 66°, carboys	lb.	.025
Alcohol, Amyl, l.c.l., drums	lb.	.15-.165
Butyl-normal, l.c.l., drums	lb.	.09
Denatured, S.D. No. 1, 190 pf., bbls., works	gal.	.305-.315
Diacetone, pure, drums, l.c.l.	lb.	.095
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385
Propyl-Iso, 99%, l.c.l., drums	gal.	.41
Propyl-Normal, drums	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.0315
Potash, granular, bbls., works	lb.	.034-.037
Ammonia, aqua, 26°, drums, carboys	lb.	.02¼-.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.05-.075
Sulphate, tech., bbls.	lb.	.035-.05
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55-.58
Sulphocyanide (thiocyanate), com'l, drums	lb.	.16
Antimony Chloride (butter of antimony), sol., carboys	lb.	.13-.153
Barium Carbonate, ppted., l.c.l., bags, works	lb.	.03
Benzene (Benzol), pure, drums	gal.	.21
Butyl Lactate, drums	lb.	.225
Cadmium Oxide, l.c.l., bbls	lb.	.55
Calcium Carbonate (Ppted. chalk), U.S.P.	lb.	.05¾-.075
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾-.06
Carbon Tetrachloride, l.c.l., drums	gal.	.73
Chrome, green, commercial, bbls.	lb.	.22
Chromic Sulphate, drums	lb.	.26¼
Cobalt Sulphate, drums	lb.	.59
*Copper, Acetate (verdigris), bbls.	lb.	.25
Carbonate, 53/55%, bbls.	lb.	.14½-.15½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, Tech., crystals, bbls.	lb.	.05
Cream of Tartar (potassium bitartrate), crystals, kegs	lb.	.23¾
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07
Dibutyl Phthalate, l.c.l., drums	lb.	.195
Diethylene Glycol, l.c.l., drums, works	lb.	.155
Dextrine, yellow, kegs	lb.	.05-.08
Emery Flour (Turkish)	lb.	.07
Ethyl Acetate, 85%, l.c.l., drums	lb.	.07
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20
Flint, powdered	ton	30.00
Fluorspar No. 1 ground, 97-98%.	ton	$60.00
Fusel Oil, refined, drums	lb.	.125-.14
*Gold, Chloride	oz.	$18¼-23
Cyanide, potassium 41%	oz.	$15.45
Cyanide, sodium 46%	oz.	$17.10
Gum, Arabic, white, powder, bbls.	lb.	.125-.14
Sandarac, prime, bags	lb.	.50
Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Iron Sulphate (Copperas), bbls.	lb.	.016
Lead, Acetate (Sugar of Lead), bbls.	lb.	.10-.12¾
Oxide (Litharge), bbls.	lb.	.125
Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Mercury Bichloride (Corrosive Sublimate)	lb.	$1.58
Mercuric Oxide, red, powder, drums	lb.	$1.81
Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Chloride, bbls.	lb.	.18-.22
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin	lb.	.05-.06
Phosphorus, red	lb.	.42
yellow	lb.	.55
Potash, Caustic, 88-92%, flake, drums, works	lb.	.07¼-.075
Potassium, Bichromate, crystals, casks	lb.	.09¼
Carbonate (potash) 98-100%, drums	lb.	.06¾
Cyanide, 94-96%, cases	lb.	.525
Pumice, ground, bbls.	lb.	.03
Quartz, powdered	ton	$30.00
Quicksilver (Mercury) 76 lb. flasks	flask	$74.-$76.50
Rochelle Salts, crystals, bbls.	lb.	18.25
Rosin, gum, bbls.	lb.	5.25-7.75
*Silver, Chloride, dry, 100 oz. lots	oz.	.40¼
Cyanide, 100 oz. lots	oz.	.39⅜
Nitrate, 100 oz. lots	oz.	.35
Sodium, Carbonate (soda ash), 58%, bbls.	lb.	.0235
Cyanide 96%, 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake	lb.	.0355
Hyposulphite, crystals, bbls.	lb.	.035-.065
Metasilicate, granular, bbls.	lb.	.0315
Nitrate, tech., bbls.	lb.	.029
Phosphate, tribasic, tech., bbls.	lb.	.027
Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.056
Sesquisilicate, drums	lb.	.0405
*Stannate, drums	lb.	.32½-.34½
Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Sulphocyanide, drums	lb.	.30-.35
Sulphur, Flowers, bbls., works	lb.	.037-.0410
*Tin Chloride, 100 lb. kegs	lb.	.37½
Toluene (Toluol), pure, drums, works	gal.	.27
Tripoli, powdered	lb.	.03
Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.36-.40
Bees, yellow, crude	lb.	.21-.215
Carnauba, refined, bags	lb.	.34½-.35
Montan, bags	lb.	.115-.12
Spermaceti, blocks	lb.	.23
Whiting, Bolted	lb.	.025-.06
Xylene (Xylol), drums, works	gal.	.31
Zinc, carbonate, bbls.	lb.	.14-.15
Cyanide, 100 lb. kegs	lb.	.33
Chloride, granular, drums	lb.	.06
Sulphate, crystals, bbls.	lb.	.04

*Subject to fluctuations in metal prices.

Metal prices on page 306a.